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The Journal
OF THE
Royal United Service Institution.

Vol. XVI. 1872. No. LXVI.

Evening Meeting.

Monday, January 15, 1872.

Vice-Admiral SIR FREDERICK W. E. NICOLSON, Bart., Vice-President, in the Chair.

NAMES of MEMBERS who joined the Institution between the 1st and 15th January, 1872.

LIFE.

Beaumont, Lewis A., Lieut. R.N.

ANNUAL.

Austen, A. G., Major-Gen. R.A.
Creak, Ettrick W., Lieut. R.N.
Dundas, James D., Major 60th Rifles.
Howard, F. C., Lieut. Rifle Brigade.
Hamilton, H. B., Capt. 6th Drag. Gds.
Miles, H. S. G., Lieut. 101st Regt.
Jackson, H. M., Lieut. R.A.
Pilgrim, Charles, Capt. Bucks Yeo. Cav.
Stopford, Hon. J. M., Lieut. Edin. or Queen's Reg. of Light Inf. Mil.
Vickers, C.B., Lieut.-Col. 48th Middlesex Rifle Volrs.
Battye, Wigram, Capt. Bengal Staff Corps.
Fynn, R. N., Esq., late Lieut. 2nd West York Mil.

The Chairman: As this is the first evening meeting of the year, the members of the Institution will be glad to learn from me that in the past year, 237 Members joined the Institution, being an increase of 59 over the number that joined us in the previous year. In an Institution like ours, a considerable accession of Members is always a good test of progress, and I am happy to say that that increase appears to be still going on. Gentlemen present, are probably aware that we are approaching what we may call a crisis in the fortunes of the Institution. We trust however that we shall come out of that crisis with an increased addition to our numbers, and with increased opportunities for lectures and discussions, such as we have had for some years in this theatre. With these preliminary remarks, I will now call upon Captain Colomb to read his paper on "The Attack and Defence of Fleets."

THE ATTACK AND DEFENCE OF FLEETS.

PART II.

By Captain P. H. COLOMB, R.N.

MUCH of the neglect under which my subject undoubtedly lies, may proceed from an idea which impressed me very strongly at one time, namely, that the attack or defence of a modern fleet cannot be profitably studied prior to the experience of many actual combats. It seems at first sight probable that no such thing as rule or law can be evolved except from the facts of experiment in war. It is therefore readily assumed that naval strategy is not yet in a condition to be made a subject of study. This line of thought would be excusable after many failures to discover the hidden law or laws which may exist, but it does not excuse the neglect to seek for them. We have no business to make the assumption in the first place, for it is founded on no data; and, moreover, I trust to have shewn in former papers that so far from being the vague conglomerate of conflicting opinion generally supposed, a very superficial analysis recovers many points of absolute certainty round which theories may safely revolve, or, at the very least, gives encouragement to persevere.

There are, however, two ways of approaching the study. The first is very easy, very common, and very misleading. The second is slow, troublesome, rare, but may lead us to the very centre of the maze. The first is the empirical or ratiocinative method—the second, the inductive. The first assumes some theory of attack and defence, some pet formation, or favourite weapon, and argues to the particulars of a combat founded on these assumptions. The latter assumes nothing at the outset. It establishes particulars by observation and experiment, and then collates, or colligates, as it has been called, these particulars, until it weaves them into general harmony. The former method *may* turn out a truth in the same way as you may throw sixes with dice. The latter method may be less brilliant, but what it establishes is reliable, and in any case such errors as occur, are capable of detection before the general result comes to be applied in war, for they must be caused either by some mistaken particular, or by some wrong application of particulars which are in themselves true.

I need not say which of the two methods has my approval, or on which of them I intend to base my present enquiry. My former paper* sufficiently shewed that I was content to make any sacrifice rather than proceed to generalise hastily. But in applying such particulars as I assumed to be established when I last addressed you, I must ask you to bear in mind that they are assumptions still, in a greater or less degree. There is not one of the points then adverted to which will not bear—nay, which does not imperatively demand—rectification by observation and experiment. I deny absolutely that we can form any correct notion of what a future naval action will be from the colligation of circumstances which we do not know absolutely to be facts. At the same time I hold in good faith to the theory that if we knew accurately all the facts which can be established by experiment and observation in peace time, we should have materials amply sufficient to guide us to complete success on the first occasion of putting our theory into practice against an enemy.

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* See Journal, vol. xv, page 405, *et seq.*—ED.

These remarks are not unnecessary at the outset of my paper. There is not one of us naval Officers who has not either heard or expressed the most decided opinions on the efficiency of certain formations and the inefficiency of others; yet I venture to say not 10 per cent. of us have ever heard any good reasons as to why one formation is better than another, and not 2 per cent. have ever thought out the matter even superficially for themselves. The danger we run of committing ourselves to some definite theory of attack and defence without any inductive steps leading up to it, is real and tangible; and if, instead of advocating a particular view, it should come to pass that I show the end farther off than ever, and leave your minds open on the questions, I shall not consider I have done bad service.

I must now advert to an opposite opinion on this matter which is held by men of greater practical experience than my own, and of deservedly greater weight. It is very strongly held by these that it is far more important to have a plan than to have a good plan of attack or defence. It is insisted that the Admiralty would be wise now, with our present information, in deciding on a particular formation and mode of attack, and in enforcing its use on our Admirals, so far as excluding all other plans from the Signal Book goes. The issue raised is very distinct, but it is not one I am called on to argue here. For, if I be wrong in supposing a bad compulsory plan to be worse than no plan, still, as no plan is yet adopted, such investigations as mine go to establish not only a plan, but, if properly conducted, a good plan, even though, as I before remarked, the attainment of one were so far off.

It is now incumbent on me to state what the aim of my arguments will be.

I understand the success of a fleet action will depend jointly or severally on four things, namely, material superiority, moral superiority, superior mobility, and superior position.

Material superiority we have nothing to do with. If we have it, and an equality in the other three things, we shall win without a discussion. Moral superiority is often confounded with strategy, and often spoken of as though it were a possession not only exclusively English, but incompatible with strategic skill or even strategic plans. I hope I should be the last to despise that fire, dash, and stolid determination which hurled a Nelson on the van of the French at the Nile, and on the head of the Mole at Santa Cruz. I trust no English naval Officer will ever forget that, guns or no guns, rams or no rams, torpedoes or no torpedoes, he who places himself most completely in the spirit of Nelson's orders to his Captains is doing the best service to the State, and runs most chance of winning. If nerve gained naval victories for us a century ago, surely those who have it in superiority possess an increased power now! But the instances I quoted of Nelson at the Nile and Nelson at Santa Cruz are sufficient to indicate that bravery and strategy combined are very much more powerful than bravery alone. The brave man had better be intelligently brave while he is about it. It may raise his reputation for pluck to win with great loss, but it will benefit the State more that he should win with small loss. Besides, a man cannot be argued into bravery, and he can be taught strategy.

Again, mobility in a fleet must be attained before the latter can be strategically employed. I pre-suppose we have it in equality with the other side. Of the four qualities set out there remains now only the last—superiority of position. What constitutes it and how to gain it, is the subject I intend to discuss.

To those, therefore, and they are many, who pin their faith on the moral superiority given by audacity and nerve, and propose without any plan to rush upon an enemy's fleet and frighten him into submission, I have nothing to say of a controversial character. I am not about to argue whether audacity be a greater or a less powerful weapon than skill. But I am about to argue, and do maintain, that audacity supplemented by skill is irresistible, and my object is to arrive at some conclusion as to how your own Fleet can be best disposed so as to allow your audacity to produce the greatest possible effect on your enemy with the least harm to yourself.

I must now set out in order those points which, discussed in my last paper, or generally admitted, have, for the purposes of my present argument, all the force of facts, and must be acknowledged as such until they are controverted.

First comes the possible speed of a fleet in action: we know that this ranges between, say, eight and thirteen knots, and if I take a mean of ten knots, I shall place myself in such a position that half my hearers will say I put it too high, and the other half too low, a sufficient guarantee for being somewhere near the truth. Assuming such a speed, enables me to deal with the all-important relations of time and space; will permit me to show what can and what cannot be done by a fleet in the time allowed; and how the skilful commander may avail himself of the limit which time imposes on his enemy's movements.

Next comes the turning power of ships, which I showed in my last and former papers cannot be taken as to space, at a smaller arc than one with a radius of two and a-half times the ship's length; and as to time, a reduction in speed over the arc of one-third. It is perhaps necessary to repeat here that this statement does represent in the rough an absolute fact; and that the figures do give the smallest space combined with the least time in which average ships can turn. If the space be diminished the time will be increased, and if the space be increased, so also will the time.

If we now take 300 feet as the length of an ordinary ironclad, we get an arc of turning for the ships of our fleet of 250 yards, and a time of turning through (say) eight points at ten knots, of two minutes.

I must draw your particular attention to the foregoing figures, because I base my whole view of naval strategy upon them, not indeed on the exact numbers, but upon their relations to each other. These relations are, in my view, the bounds within which the strategist must work, and beyond which he will only fail in attempting to pass. It is no use to call them matters of detail or assumptions, they are vital principles; and the only assumption about them is the exactness of the figures. Ships may not be 300 feet in length, but the shortest turning ironclad which has ever been built, going at her highest speed, takes about a minute to turn through eight points on an arc whose diameter was 5·2 times her length, reducing her speed over the arc by more than one-tenth.

The next point to be considered is the gun-power of ships. I laid it down last year from the best data obtainable, that only about 10 per cent. of the shot fired from a sea-going ship would take effect upon another broadside-on, and at a fixed distance of 1,000 yards; and that the highest speed of fire which could be calculated on, was about one round in three minutes. The damage done by hits at that range was of course not easy to estimate, but except at close quarters, when the shot strike fair on the broadside, all allow it to be small: the effect of hits received when end-on is generally considered to be *nil.*

I held the ram to be the effective weapon in a single-ship action, the gun being subordinate, unless the Harvey torpedo should supersede the former; and while on this subject, I must say two words. I have usually in my papers stated that the idea of the ram originated in our Service, with the gallant Admiral of the Fleet, Sir George Sartorius. He will be pleased to know that another Officer, Sir James Sulivan, was, contemporaneously with him, pressing the weapon on the notice of the Government, and assisting in that development which we are yet so far from seeing complete.

Again, I have seen, since I last addressed you, the Harvey torpedo in action, and I have modified my views of it. It is not, in my opinion, so powerful a weapon as I formerly believed it to be. To use it effectually, special ships of high speed must be employed, and even then, much more skill is required than I imagined necessary. It seems to me also, that the mitrailleuse or volley-gun will be a very effective defence against this torpedo. It would be used both to sweep the manipulators off the decks, and also to destroy the torpedo itself. In any case, it must here be said that even when I read my last paper, I could not view the Harvey torpedo as an effective weapon in fleets. It is true that one or two special ships towing torpedoes, might, as an *avant garde*, throw a hostile fleet into some confusion; but, as the enemy might equally well employ the same weapon, we should have a combat of torpedo vessels between the fleets before they met, which could not lead to decisive results. If this torpedo is ever rendered powerless against friends, fleets might employ it with greater reliance on its power, against enemies.

I now arrive at a point on which there is not, and cannot be any data, but which universal assent has established as a fact. I allude to the general understanding that whatever formations may be in future assumed by two hostile fleets in action, the ships composing them will always be end-on, and never broadside-on to the enemy. Some explanation is required to shew how I look on it.

In my last paper I endeavoured to shew that, prevalent as the notion was that the end-on position was that which a ram would assume towards another ship in action, it was in reality a false one. I showed that this was quite a right position for a ship *not* herself a ram, and desirous to avoid being rammed, but that if a ram were so to range herself she could never strike at an advantage. I find now very many Officers hold that I am wrong, not in upholding the advantage of making your stem take your enemy's broadside, but wrong in believing that two ships will seldom, or never, meet stem to stem. It is difficult to argue either side of the question, but I may note that the Russian gunboats never met stem to stem in their experiments; and I may express my firm belief that one or other ship will in such a case swerve at the last moment, and pass broadside to broadside without any result from either ram. Those who think otherwise must remember that there is no analogy between the old principle of getting broadside-on to your enemy at pistol range, and pounding him till either one or the other struck, and the stem-to-stem encounter between two rams. The superiority of the English seaman in our old wars lay in his muscle and his steadiness. The weakness of our enemies was never in material, but they failed in nerve and stolidity. It was the height of strategy to bring our strong points against his weak ones, and broadside to broadside did this in perfection. But for one ship to run against another, stem-to-stem, is no strategy, but rather a reckless blind trusting to chance.

The victory depends upon which ship turns out to be hardest, and the spinning of a teetotum will represent the chances on either side. The strong probability is that if two ships met at speed, stem-to-stem, the shock would be so terrific that both combatants would instantly disappear.

I am saying nothing here of the policy of charging straight down upon your enemy in the belief that he will flinch from his end-on position before the last moment, and give you the opportunity you seek. Such a course may be the most excellent strategy, as you are opposing your presumed strength of nerve to your enemy's weakness. I have before said, however, that I have nothing to do with strategy of this kind, and if a stem-to-stem encounter is contemplated in any other view, it will, I think, be a very foolish proceeding.

If there is anything to be said on the other side, I am not now aware of it, and I therefore base all my ideas on what I have here stated.

Those, therefore, who think with me, will observe the instinct of the naval world has led it to contemplate the end-on position for hostile fleets, not as the best means of attacking with rams, but as the best means of frustrating an attack of rams. Our opponents will take the opposite view. The latter party will maintain that the ram dominates and prescribes the formation, and is itself the chief weapon; I, on the contrary, conclude that the ram dominates and prescribes the formation

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DIAGRAM IV.

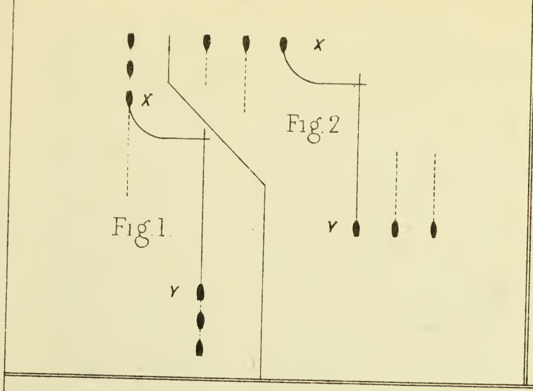


DIAGRAM VI

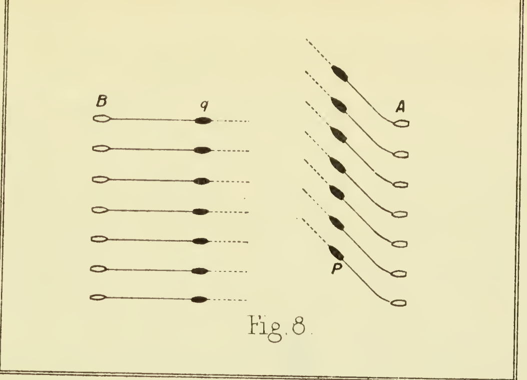


DIAGRAM VII

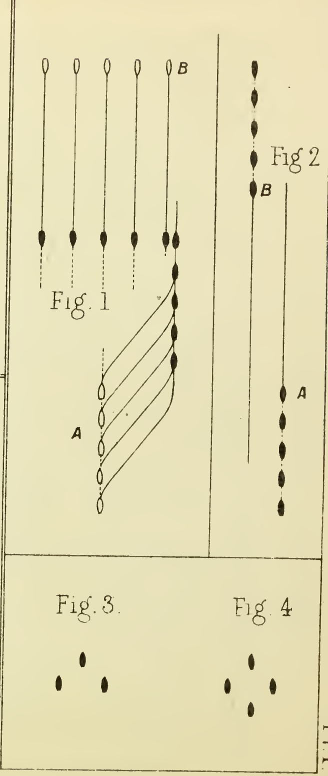
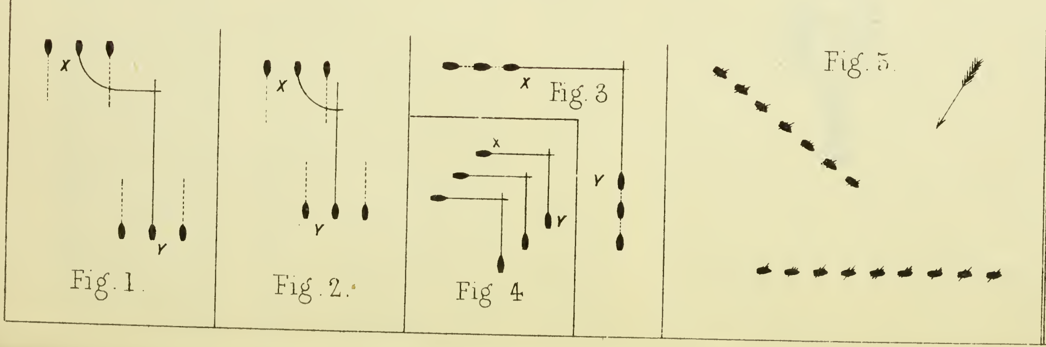


DIAGRAM V.



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which is so good a defence against it, that the ram is not the chief weapon in fleet actions. And the inefficiency of the ram as the chief fleet weapon, once the end-on position is firmly established, seems to me to be argued by other considerations which I have not yet seen treated by any writer on tactics.

If we examine the ramming tactics for single ships laid out in my last paper, and endeavour to apply them to fleets, we shall soon see, I think, their inapplicability. Take Diagram I, figs. 7 and 8, and Diagram III, fig. 1, of my former paper, and you will at once note that the mode of approach is of small value. If x and y, Figs. 7 and 8, were leaders of single columns in line ahead, as in Diagram IV, fig. 1, it is apparent either that the leaders alone would encounter, or that the turn of x to ram, throwing her broadside open to the next astern of y, would be taken advantage of by that ship, and even if x succeeded in ramming y, she would herself be rammed in turn. So if x and y were the port wing ships of single lines abreast, as in Diagram IV, fig. 2, their manœuvres would have no reference to the remainder of the fleet. If x and y were not wing ships, but some other ships in the lines abreast, as in Diagram V, fig. 1, then x must make his turn astern of his left hand neighbour; he lays himself open to attack by y's left hand neighbour, and breaks the order of his own line, cutting himself off from support at the same time. Should he, however, use the short turn, as in Diagram V, fig. 2, his manœuvre will be baulked by his own left hand neighbour, to avoid whom he must exercise caution, and who more or less hides the object of his attack, just at the moment when all depends on his getting a clear view. He again lays himself open to the attack of y's left hand neighbour, or, if he misses y, of his right hand neighbour.

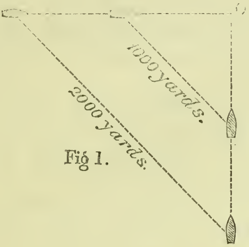


Fig 1.

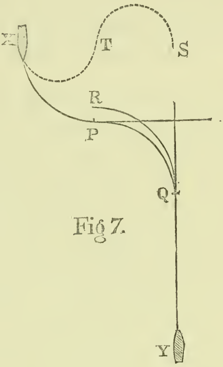
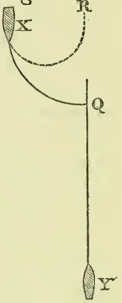


Fig 7.

Fig 8.



If x and y, however, being leaders of lines ahead, choose the 4-point method of approach given in Diagram III, fig. 1, the rest of the fleet does not partake in any of the advantages of the mode of advance, as may be seen from Diagram V, fig. 3. If, however, they were the leaders of columns in quarter-line, as in Fig. 4, their tactics would equally apply to the ships astern of them. But the difference is, that

x is no longer solely occupied with his attack. If his own next astern by any accident lets y's next astern slip past him, x has two ships upon him, and fights at a disadvantage. We see running through all these positions a principle by which, in formation, one ship covers or guards another from a ramming attack, and renders useless the methods which are available between single ships. The fleet which rigidly maintains its end-on position, and whose ships only swerve from that to deliver their blow upon the enemy, who presents his broadside while attempting to ram the ships to whom they are guards, goes into action with an advantage, for it runs no such risks of being rammed as its opponents who seek to attack in that manner, and while it never drops its own guard, it is ready to take advantage of any slip its enemy may make.

Naval strategy, therefore, while it dictates an attack by the ram by single ships as the most effective means of obtaining the victory for him who is most skilful, does not seem to me to advise that policy in a fleet attack. You must beat your enemy in some other way.

Before leaving this part of my subject, it is necessary to point out that some ships in every formation have no guards, and are open to the same attack as single ships. The rear ships in line ahead are open to the ramming attack on both sides; and the wing ships in lines abreast and quarter lines were open to attack on their outer sides. Hence, although you cannot, as it seems to me, make your general effort a ramming attack, you will be foolish to avoid any opportunity which offers of attacking particular parts of your enemy in that manner.

We are now in a condition to apply the principles we have brought out to the actual business of my paper, the Attack and Defence of Fleets.

In all sea-fights of former ages, we see either of two conditions; both fleets equally ready for the combat, or one assuming from the outset the attack, and the other the defence; the former condition is rare. Hitherto, I believe, no case has occurred where—as in so many battles on land—a skilful movement has converted the defence into an attack. The most that could be done in former times was practised by the French, before the revolutionary war, in taking advantage of the weakness of the British attack to damage them seriously while keeping themselves out of harm's way. Clerk of Eldin shews that in the attack from to windward, generally practised by us before Lord Rodney's victory changed our views, we really offered a portion of our fleets to the whole fire of the enemy, as shewn in Diagram V, fig. 5, and the van becoming disabled from this cause, the French were in a position to bear away to leeward to re-form, and to repeat the manœuvre, which they usually did.

Sir John Jarvis at St. Vincent, and Lord Nelson at the Nile, are brilliant examples of an opposite mode of proceeding, and though the approach of Lord Nelson at Trafalgar might seem a recurrence to old methods, it was not really so, as the enemy's fire was divided between two vans, and the approach was direct, and as rapid as it could be, instead of the slow and "lasking" approach, as it was called, shewn in Fig. 5, Diagram V.

In the changed condition of things now, we must be very careful to guard against following history too blindly as our guide; but, at the same time, we must by no means neglect to avail ourselves of the lessons she really teaches; though, therefore, the *manner* has passed away, the *matter* remains as worthy of adoption as ever it was.

I think now that steam has done much to alter the former state of affairs, and that an inferior fleet may, when direct attack is not at first attempted, convert a defence into an attack, and perhaps even gain a victory.

The principles of a skilful attack or defence must ever remain the same; they must always be the offering a superior force to an inferior; and if a part of the enemy's fleet is made to bear the brunt of the whole of your own, the greatest strategist can do no more.

I am sorry, however, to believe that we are at present drawing more inspiration from the manner of our forefathers in naval tactics than from the matter. I do not think we have shaken ourselves sufficiently clear of the traditions of naval sea fights to perceive the laws which underlie them, and become applicable to our own times. In days of yore we had a broadside position; small sail; and low speed. Now we have the end-on position, and great speed. I do not think, from all I have seen and heard, that naval minds habitually dwell on the speed at which future actions must be fought. It is known and acknowledged that a ship without speed, if met by a ship with speed, is doomed to certain destruction by ramming, but in spite of this, the picture of a fleet action naval men have before their eyes, is always a confused assemblage of ships more or less stationary. It is quite common to hear it said that "the best tactics are for every captain to put himself alongside an enemy's ship," as if such a thing were now possible, unless the enemy's ship were a consenting party. The French system of tactics did much, and Lissa did more, to confuse the picture of a future sea fight, and to paint it as a *melée* of independent attacks. The *melée* at Lissa was entirely due to the broadside position of the Italian fleet, and its want of speed; two concomitant blunders which no commander will ever be mad enough to bring together again. Had it been otherwise, Tegethoff might have had his *melée* to himself, but the Italians would have been out of it from their own impetus. If two fleets charge one another at ten knots in the end-on position, three minutes will elapse between their being a mile apart and their meeting, and in another three minutes they will again be a mile apart. If the very instant after one fleet had passed through the other, they put their helms hard over, still the other fleet would be three-quarters of a mile away before the first was in pursuit. Under such circumstances the only *melée* will be amongst the wounded birds, and the type of the battle would be a rush, a contact, a separation, a re-formation, again facing each other, another rush, and the same thing repeated.

The other type of action—still due to speed and the end-on position, would be where one fleet retires before the other until, by happy skill, or by happy accident, it is able to face its pursuer with advantage.

How to face your enemy with this advantage, how to bring your whole fleet on a portion of his when facing him, seems to me the problem before us.

We shall all be agreed, I think, that anything like elaborate manœuvring is out of the question, except in the process of retiring. The mere moment of time which elapses between the coming into range of two approaching fleets and their shock, renders either manœuvring or signalling absolutely out of the question. Nay, even after sighting an enemy's fleet—say ten miles off, he will be a hardy admiral who attempts to do more than throw his fleet into the formation he intends to fight in. In such circumstances, the fewer signals the better, as a mistake might be fatal, and the chances of mistake are trebled when the nerves are tightly strung, as they would be at such a moment of excitement.

The very numerous, and sometimes eccentric, fighting formations which are proposed for adoption by our own and other Navies, may be classified under four heads; which, on still closer examination, may for the purposes of argument, be resolved into two. These are—

(1). An extended front, with small depth.
(2). A narrow front with great depth.
(3). The mass or square, where depth and front became equalised.
(4). The system of groups, however, disposed. The principle being that the attack or defence is not concentrated, each group making itself felt as occasion offers.

The mass, or square, must possess in a less degree the advantages and disadvantages of the extended and narrow front, and of the small and great depth.

The groups must be disposed either along an extended front or along an extended depth, and, therefore, must, so long as they remain in formation at all, possess the weakness or the strength of those formations.

If, however, we reflect a moment, we shall see that when an enemy's fleet is approaching in an order of battle, all that can be detected in the few minutes of time allowed, will be either its extended front, or its extended depth. Therefore, although if time permitted, I might go into greater detail, I think that I shall best argue out the principles I have in view by imagining all formations classed under the two first heads, and considering the relations between an extended front, as opposed to an extended front; a narrow front and great depth as opposed to an extended front and small depth, and a narrow front and extended depth as opposed to the same formation. A few words will then suffice to treat of the mass or square, and of the system of groups.

It will also, I think, conduce to clearness, if I do not go beyond the two representative formations of the extended front and the extended depth, namely, the single column in line abreast, and the single column in line ahead.

The attack I define to be when the ships keep their heads towards the enemy, advancing, or trying to advance on him. The defence is when the fleet retires before the enemy.

In the attack there is always one enormous advantage on the side of that fleet which takes the initiative. Ships cannot move simultaneously, except by signal. One or two ships may turn so closely after each other, moved by a common impulse, as to be practically simultaneous in their action; but this cannot be carried throughout a fleet. It follows, then, if there is not time to make a signal after the nature of the attack is disclosed, neither will there be time to manœuvre so as to counteract it. The Admiral assuming the initiative, or advancing in such a way as enables him to assume it without a signal, may do so with some security against a counteracting movement. While he who waits till the attack is developed in the hope of counteracting it, runs the risk of not being allowed time to do so.

Taking, now, Diagram VI, we have two fleets 2,000 yards apart approaching at the rate of 20 miles an hour. The fleet A may pass straight on, bearing down upon B, without alteration of course. In the three minutes elapsing between getting into range and contact, one, or at most two rounds may be exchanged. Supposing both fleets had been stationary at 1,000 yards, and each ship in A fired two guns at B, between one and two shot might strike, with a chance of penetration or damage at its minimum. But the fleet target, so far from being stationary, is altering its range eleven yards in a second. Under such circumstances, to fire is to waste powder A had better proceed without firing and with his guns concentrated right abeam and horizontal, ready to discharge point-blank into the enemy in passing, should his ships maintain their end-on position and so elude the ram. B, under present circumstances, ought to reserve his fire, and hence, when the two fleets have passed through one another, they will have fought on an absolute equality, and any less damage done to one or the other must be due to stronger plating, bad practice on the other side, or the chapter of accidents.

But, consider how very dangerous this method of engaging will be to the friends on both sides. In the confusion, excitement, and smoke, how more than likely is it that a friend will receive the broadside intended for an enemy? True, each fleet runs an equal risk of this, just as each runs an equal risk of being rammed. But to run these risks is not strategy, and it is, I think, plain on these grounds that an attack made direct, by an extended front, ought not to be met by a counter attack of the same nature.

It will be open to A, if there is time to make the signal before getting into range, to put in force the application of ramming tactics formerly mentioned, and by altering course together four points either way, to endeavour to force a similar movement on the enemy, and thus to convert an artillery combat into a trial of skill in ramming. If this movement were made at the moment of coming into range, the new positions of the fleets would be at *p* and *q*. It is pretty clear that A's manœuvre has no forcing effect whatever on B, who, on the contrary, appears to have certain advantages placed in his hands which he had not before. It is true that, for a moment, the artillery of A may be held superior to that of B, inasmuch as he can probably bring more guns to bear. But this advantage passes away as A moves to the right along the front of B, and besides, A receives the shot of B more directly perpendicular to his broadside than does B those of A.

But while the port-wing ship of B is guarded from rams by her right-hand neighbour, the port-wing ship of A is not guarded at all, and should be the object of B's attack by ramming.

Except these alterations of course together, which must be ordered by signal before getting into range, there appears little that A can do so long as he remains in line abreast; and if it be as appears, that he gains no advantage either in a direct advance or a four-point advance, it seems to me he must give up the extended front if he wishes to attack an extended front with an advantage.

Let us therefore examine the extended and narrow fronts as opposed to each other. This we have in Diagram VII, fig. 1. We suppose two fleets, A and B, observing one another at sufficient distance to allow of consideration and to the coming to the conclusion to attack: but A determines to do so in a formation with a narrow front and B with an extended front. The headmost ship of A has approached to within 2,000 yards of B's ships. Let us see how matters stand between them. A's leader is open to the fire of the whole of B's bow guns, a fire which we have before shewn to be ineffective. That is her whole disadvantage. On the other hand she is within three minutes of contact with B's fleet, and yet has not disclosed the nature of her attack. Supposing the Admiral of A to be leading, his orders would be to the ships astern of him to follow his motions *together*, as nearly as possible, to concentrate their guns at point blank, right ahead, and to pour in their shot on the instant of passing an enemy's ship.

A has three attacks open to him: the centre or either flank of his enemy, and leaving him in doubt up to within three minutes of commencing his attack, it is manifestly impossible for B to counteract him even if there were a movement capable of doing it. Suppose A chooses to pierce the centre, and therefore simply continues his course; as he passes between two enemy's ships he certainly receives their two broadsides; but if he be equal in power on both sides he gives them as good as he gets, with this advantage, that his shot which miss one enemy's ship may hit another; while the enemy's shot which miss him may damage their friends. But if A's leader has already been subjected to bow fire from those ships between which he passes, they will hardly be ready in the time to give him broadside fire as well from these guns. But in any case, the moment A's leader has exchanged broadsides with her enemies, and long before they are in a condition to fire again, a succession of fresh ships pass into her place at the rate of one every twenty seconds or thereabouts. The two ships between which A is effecting his passage will thus receive five broadsides apiece in about a minute and a half, without more than a single reply, and if this is not enough for them, I think it ought to be.

Here we have the process of "doubling on the enemy," as I conceive it must in future be practised. The principle remains the same as ever, only the detail has altered with the times. Instead of doubling simultaneously and so placing a ship betwixt two fires, we must now double in succession, serving him with a continued succession of fresh ships.

The only objection I can see to this centre attack is, that you lay yourself open to the fire of both flanks on your near approach, whereas, by attacking on the flank, you can receive no more than half that amount.

In this attack, if the Admiral chooses to threaten the centre till close up with the enemy, which I think will be hardly necessary, his ships should turn together towards the intended flank and then turn again into line ahead, as shown in the diagram, pouring in successive broadsides into the enemy's wing-ship in passing. A's rear ship should, I think, be directed to attack the wing ships of the enemy with his ram, and for this purpose should steer further out than the ships ahead, so as to give himself room to turn. His orders should be not to embroil himself by making a second attempt if he misses the first,—indeed, he can hardly obtain a second opportunity,—but to follow the rest of the fleet, which should re-form with their heads again towards the enemy, ready to act again as may be necessary.

There are in this kind of combat a variety of circumstances to be noted which seem to me to tell in favour of A's attack. If there is no wind, A's ships after the leader, will observe B's wing ships emerging from the smoke of their own and A's guns, before they themselves have entered it. They will consequently be more masters of the situation than B's ships can possibly be. If B's whole line continues to fire from his bow guns, as no doubt he would, there is the greatest danger of his line getting into confusion, and also of some of the shot intended for an enemy reaching no further than a friend. It is, I believe, a fact that with modern heavy guns the compasses are thrown completely out of gear, so that no formation can be maintained by compass while firing.

In A's advance the compass is not appealed to at all, as each ship simply follows her next ahead in the closest possible order; and although the formation will probably be broken ultimately, this will not happen till its work has been done, and it is clear of smoke in rear of the enemy.

If the wind were blowing towards the attacked flank across the enemy's front, his view will be interrupted, and his fire will slack. But the smoke may also shroud A's ships from one another even before they fire, and their broadsides may be thrown away.

If the wind is from the attacked flank A will always be in the clear, while the ships of B's line will be shrouded, each one by the smoke of his neighbour.

I think, therefore, that A should choose the weather flank for his attack. If the wind be with B's fleet, so much the worse for him, while it will not affect A. While, if the wind be with A's fleet, the conditions will be those of a calm, except that A will be longer in his own smoke after he has passed the enemy.

But while showing the advantages of thus opposing a narrow to an extended front, we must not omit to ascertain what possibilities of defence lie in the extended front. At first sight, many movements will suggest themselves as practicable, but when we apply the rigid standards of time and space, we shall think differently.

Remember, there are but three minutes in which B must form and execute his plan. On the face of it, therefore, there can be no combined manœuvre not previously arranged. No previous arrangement could embrace more than a single movement, yet there is no single movement preserving the line abreast, which can be executed in the time and space except by surrendering the attacking position.

Suppose B were to hope to swing his line round on his port wing-ship as the pivot? To do this, the port wing-ships, the very object of his solicitude, must reduce their speed, enabling A's rear-ship, already warned, to ram them with ease. But in no case can B's starboard wing-ship come upon A's rear-ship in time. Again, B surrenders his bow-fire in attempting any manœuvre, for it is admitted by all impossible to manœuvre in smoke. Besides, any one who has experience of fleet manœuvring, is aware of the difficulty of preserving the formation when swinging round, even for drill purposes.

Single ships, it has been said, may pierce A's line or ram him. This is so, but only by passing astern of their friends, and so separating from them and plunging into the midst of their enemies, can they effect their purpose. But then they pass at once into the heaviest of the smoke, and run at least as great a risk of destruction themselves as they bring upon their enemies.

On the whole, therefore, my view is, that an extended front is an exceedingly weak formation for attack, and ought to succumb to the narrow front in all cases where things are otherwise equal.

But the extended front may, when time permits, be changed for the narrow one. If B, surrendering his idea of the line abreast, were, on perceiving A's approach in line ahead, to meet him in the same formation, he would advance his port wing-ship and form astern of him.

This would give us the narrow front as opposed to the narrow front, shown in Diagram VII, fig. 2, and I think we see the balance is restored, and that if both fleets so advance, they will fight on an equality.

It is of course useless, and perhaps foolish, for the leaders to open fire till abreast of each other; they will then exchange their broadsides, and if they both pass on, will each receive the broadside of fresh ships before they can reply effectually. Here the same qualities might stand the British seaman gunner in as good stead as formerly, provided, that is, that machinery more perfect for working guns is not adopted by other nations, and a rapidity of fire obtained, which we cannot compete with.

But without this, or in spite of this, A may by proper orders to his ships, gain an advantage over B.

Suppose, for instance, that A's leader, and each ship astern of him, were ordered the moment they had fired their broadsides, to turn sharp off to starboard, B's fresh ships would never get the opportunity of firing at all, and his leader and her next astern, would have received the fire of the whole of A's ships. When the smoke cleared away, A would find himself in quarter line with B in his rear, and might determine on the next stage of his attack.

I have now discussed as closely as time permits, the principles of Naval Strategy in the attack as they have presented themselves to me after such limited examination as I have been able to give to them.

It will be seen that I believe the extended front to be a weak formation, and that in no case should it be taken up in an attack. It has appeared also in the course of my enquiry that the bow-fire, on extreme training of guns, is not of great value, and that more is to be done by broadside fire in attacking fleets. These conditions appear reversed when one fleet retires before another. Then, unless the pursuer can enforce by his speed, or the pursued takes up for himself, the position of attack, the result must depend on the goodness of the gunnery practice. The pursued must spread out an extended rear, and the pursuer an extended front, in order to get the full value of their artillery. Here the distances will be fairly permanent, and the bow and stern fire becomes effective. I cannot conceive, however, a decisive victory gained on such principles; and for the defence, I would rather convert it into an audacious attack upon either flank of the pursuer in the manner before described.

I have already stated that if a formation, such as the hollow square proposed in Russia, possesses depth and extended front in combination, it possesses also the weaknesses and strengths of each quality, and therefore, if the better qualities of the line ahead be opposed to the less good ones of the shorter side of a square, there will still be an advantage, though not so great on the part of the former.

These compromises seem to me to be proper for adoption by such nations as, from their want of naval prestige, may be more solicitous to guard against defeat than to ensure victory. I must own my sympathies lie in the direction of audacity, and a determination to win all or to lose all ; and hence I do not so much concern myself with half measures.

It will be seen that I lay great stress on compactness and concentration in attack, and I am in consequence opposed to systems of reserves of separate fleets acting conjointly, or lastly to the attack or defence by groups.

I cannot at present see how, when fleets are at speed, a group can act independently without running the great risk of finding itself surrounded by enemies and beyond the support of its friends. Suppose a group such as Figs. 3 and 4, diagram VII, opposed to even the same number of ships only, in close order in line ahead. The broadside fire of one ship in each formation is masked, and in Fig. 3 the attacking force of three ships would receive one broadside from the leader at double distance, and one from the wing-ship at close distance. But this wing-ship would get in return three broadsides at close distance. So with four ships in line ahead attacking the group of four. The leader might sustain one broadside at close distance, and two at double distance. But the wing-ship would sustain four broadsides at close quarters. Then observe the weakness of these groups in the matter of ramming. Fig. 3 has two ships out of three, and Fig. 4 three ships out of four, unguarded. Such an opportunity for the ram-ships of a line ahead is all that can be desired, especially in Fig. 4, for the ram which misses the wing-ship, will almost to a certainty catch the rear.

Such, then, is my slight summary of the line I conceive our study of Naval Strategy should take. I should be very sorry, indeed, to dogmatise on a subject which is to all intents and purposes a new science, but I hope to have shown that there are sound principles to be got at even in peace time, if we will only take sufficient trouble to find them.

Commander Dawson, R.N.: I hope that nothing may occur to this Institution to prevent for the future our having the pleasure of receiving information from the lectures that are occasionally given here upon the principles of "naval tactics;" for I do not know where else we should be able to gain any information upon that subject. It is true we have a Naval College at Portsmouth; but I am not aware that there is any Professor of "naval tactics" there. I understand that at the Military College there is a Professor of "military tactics." We have heard of a "Professor of military history" at that college; but I am not aware that there is any "Professor of naval history" at the Naval College. There is also a "Professor of artillery" at the Military College; but not one at the Naval College; even naval architecture is not taught there, so that we are really dependent upon this Institution for any information that we may obtain as to the principles of naval tactics, naval gunnery, and collateral subjects. Turning from this subject, I remark in this paper that there is not a single fact brought forward showing that the British Fleet, which costs so much, has done anything to elucidate any of the questions which arise in determining the best way of using the various novel ships and weapons with which it is furnished for purposes of war. I do not mean to say that the Fleet has made no experiments, practised no war-like manœuvres, or gathered no useful experience, but I merely draw attention to this circumstance, that if any portion of the Fleet has elaborated experimentally any facts bearing upon future wars, they have not been brought forward now; and, as far as my information goes, these experimental or other experiences have not been communicated from that necessarily small portion of the Fleet which may have gained the knowledge, to the Officers of that other larger section of the Fleet which has had no opportunity of acquiring it for themselves. Nor do I believe that there is any means in existence by which such experience can be communicated from those who gain it, to those Officers afloat who have not that opportunity. This waste of experimental experience and professional knowledge is a very important point, to which I wish to direct attention. Passing from the absence of facts, it appears to me that the future tactics of the Navy depend upon the relative values of the weapons with which we are going to fight. I concur with a good deal, in fact, I almost entirely concur with what Captain Colomb said as to the dangers that may be anticipated from, and the skill which is required in, the use of the present Harvey torpedo in a general engagement. That is one of the things which it appears to me ought, in time of peace, to have been long ago found out by the Fleet and remedied. The Harvey torpedo has been spoken of before the world for twenty or thirty years, and was adopted as a fighting weapon for the British Fleet about two or three years ago; so that Captain Colomb ought to be able to say that the Channel squadron, and the Mediterranean, the detached, and other squadrons, as well as single ships, have during those three years handled these Harvey torpedoes in every possible way; that they have found out that such and such is the case, and that such and such is not the case. Again, it is twenty years ago since Sir George Sartorius and Sir Bartholomew Sulivan advocated the employment of the ram, and for the last ten years every ship built for the Navy has had her bows fortified and armed for ramming; yet we are theorising on the subject to this hour, without a single ascertained fact being produced able to show that any British ship or squadron has done a single thing to elucidate that subject, or that a single British Officer has gained an atom of xperience in this weapon with which so many of our ships are provided. We are bliged to go to Russia to find out what the ram can do, and to borrow the practical xperience of the Russian Navy; the captains of which are regularly trained to its se. I am one of those who think that the Harvey torpedo is right in principle, and hat a little money for experiments, a little experience, and a little talent applied to , would make it a very safe and a very destructive weapon. But, even taking it as is, it is a very formidable weapon. Look at that diagram No. 6, showing two eets in line abreast meeting end-on. Only three minutes will elapse after coming ithin range of fire, before they meet. If at the beginning of those three minutes he ships of one fleet, or of both, were to extend a Harvey torpedo on both quarters, nd were to still continue their courses, the consequences would be something fearful. f the Harvey torpedo in its present condition is not powerful enough to break hrough an armoured ship at the water-line, I do not see any difficulty in enlarging s capacity and introducing a detonating explosive which will readily do so. If we o not employ the torpedo, the Russians will, and I should advise them to put a little ore dynamite or gun-cotton into it, and make it powerful enough to perforate rmour plates at the water-line. The Harvey torpedo might be doubled or ebled in capacity without any great increase in dimensions and without losing its andiness. As to its safety as regards friendly ships when employed in a general tion, I see no difficulty in the application of electricity to the Harvey torpedo as he igniting agent, and then it would be absolutely innocuous upon accidental contact ith friendly vessels, as it could only explode at the will of the operator, who would ot make the connection with the electric battery till he saw the torpedo approaching hostile ship, and the wire could be disconnected on a failure to make contact. As the risk to the torpedo-operators from artillery or Gatling-gun fire during the three inutes that the two fleets are approaching under fire, I do not think it would be ery much if the vessel operating was an ordinary ironclad, armed as usual with guns. he difficulty is one that the Fleet ought to have experimented upon and determined ng ago. In the absence of practical experience on the part of our Navy, my opinion that there would be no difficulty, providing there was suitable cover for the ope- tors; and if that was done, the danger from artillery or Gatling-gun fire would be vercome. At any rate difficulties are made to be overcome, and it ought to be the usiness of the Navy, as a training school for war, to attack and conquer them, and hat better training for war than that our sea-going Officers should experimentalise pon their weapons, record those experiments, and communicate their failure or suc- ss to the rest of the Navy? Believing as I do that a good deal may be developed ut of improved naval torpedoes, and that torpedoes in one form or another will be sed against us in the open sea, whether we employ them or not, I think the torpedo ill govern the tactics of the Fleet; though, when both sides are armed with it, it ill only serve as a defence against rams and against hostile torpedoes, and will thus ecome a defensive rather than an offensive weapon. It will be utterly impossible r one ship to pass within 200 yards of another vessel towing Harvey's torpedoes; nd, if both sides are equally armed, fleets must keep at that respectful distance. ence it follows that fleets will not attempt ramming, because they cannot approach ithin 200 yards without mutual destruction. The action will then resolve itself ntirely into an artillery contest. Now, we have made tremendous strides in artil- ry of late. It is only six years ago that we were told by the highest seaman-like uthorities, that it was utterly impossible to work guns of more than six tons weight n the broadside. We are now able to work 25-ton guns upon the broadside. The 2-ton guns can be fired once every minute, whilst the 25-ton gun can fire one shot very two minutes. Nothing could be more efficient or more secure than the means y which these ponderous guns are manipulated, so far as training, running in and ut, and elevating is concerned. The mounting of guns has a large influence upon heir accuracy; a smooth, regular, yet rapid movement assisting the aim very con- iderably. But the loading arrangements are exceedingly slow, clumsy, and unsafe, nd might be much improved, which would increase the rapidity of fire. We were old by Captain Colomb in his former lecture, and I quite concur in the observation, hat the accuracy of the fire of our few heavy rifled guns is very small; that not bove one shot in every ten was expected to hit the mark. Now, accuracy of fire is question which it is the province of naval gunners to be able to deal with. I am sure if good sea-shooting was a military question, we should have had three or four committees appointed, who would have experimentalised for years upon it, and we should have had a great many blue books and exact records of several thousand rounds to refer to; but as it is a naval matter, we have no information upon the subject except the one experiment in the Channel squadron, which Captain Colomb has quoted. Now, good shooting at sea depends, amongst other things, upon knowing the range. Admiral Ryder elaborated tables and methods for ascertaining distances, twenty years ago; and to this day there are no means taken to give effect to those tables and to carry them out by stationing people for the purpose of observing the distances, except when firing at a target from the larger ships. It ought to be done to all vessels on every occasion of going to quarters. There is another serious difficulty in the way of obtaining accuracy of fire under lively rolling motion at sea, and that is that the new rifled guns are very badly sighted. The old 68-pounder in a lively sea can now make better practice than one of our 9-inch rifled guns. This arises from the new guns being so badly sighted, the smallest visual error in taking aim having a much greater effect upon the range than a like visual error in the old guns, owing to the decreased distance between the rear and fore sight in rifled guns. On ordinary occasions the line of vision of the captain of a gun standing six or eight feet from the rear sight, must pass above the tangent sight. The vertical height which the line of vision passes above the rear sight constitutes a visual error, which is the cause of all large errors in the range, when firing at known distances. This visual error may be taken at two-tenths of an inch at ordinary times, but, when in lively motion, the shot falls 300 or 400 yards beyond the target, the vertical visual error is evidently considerable. The value in range due to a given height of line of vision above the rear sight depends upon the distance between the two sights. A visual error of half an inch over the tangent sight—not a very large one to make with lively motion—will, in the 68-pounder, amount to about 180 yards at 1,000 yards' range; but in the 9-inch rifled gun it amounts to more than double that distance. And if the dispart sight be removed, the difference between the two would be such that the 68-pounder would, at 1,000 yards' distance, make about one-fourth the amount of difference in the range for that half-inch visual error. This has an important influence on good shooting from lively ships. The power of the guns may be very much enhanced by a better system of rifling. The present system of rifling altogether fails to give rotation to long shells such as the guns are designed to project. Instead of employing a known system which will give the necessary rotation, we reduce the weight and capacity of the projectile, thereby sacrificing one-fifth the weight and two-fifths the bursting power of the 11-inch guns, and one-half the shell power of the new 35-ton gun. As guns are reduced in number, it becomes more essential to study the effective use of individual guns, and we can scarcely afford to sacrifice so much of their naval efficiency to a bad system of rifling. If I am correct that future naval tactics must be directed to the most effective employment of artillery fire, then the improvement of artillery fire is brought into greater prominence than ever, whilst in our more recent constructions, the number of guns carried has decreased so very much. Many of our older ironclads want re-arming, their armaments being incapable of penetrating the newer vessels. There is no essential connection between weak armour and weak guns, and no reason why an "Agincourt" should not perforate a "Hercules." In the confused *melée* of a general action, it is impossible that hostile ships should seek out the one carrying corresponding thickness of armour, even if the thickness was legibly marked on each broadside. Without dwelling any longer on the subject of guns, it still appears to me that "tactics" depend upon the weapon you make use of. Captain Colomb has thrown over a most important weapon—the gun, and has based the principles of tactics upon its non-employment in general actions. If that weapon is a reality, then all his principles of tactics are wrong; if that weapon is not a reality, then the principles of tactics enunciated are right. I am sorry that in such vital questions, speculative opinions can alone be advanced in discussion on one side or the other, instead of our being able to deal with ascertained facts. It would be far more satisfactory to be able to say that so many ships had under so many different conditions, made such and such experiments with such and such results. But in the general ignorance which obtains afloat as to the capabilities of modern ships and weapons, I cannot point to the experience gained, but must deal only with speculative reasoning. I want to clear away the ground as to the weapons to be employed, in the hope that those who follow me, and who may have had more experience than I have in antiquated parade fleet movements, may tell us, in the case of a fleet so circumstanced that artillery fire is to be the deciding weapon, and that ramming is rendered impossible because of the use of a safe and powerful torpedo, what are the tactics which should then be employed.

Admiral of the Fleet, Sir **George Sartorius**: I wish to make one or two personal observations with regard to what Captain Colomb has said as to the priority of advocating the ramming principle. It is an old principle. I never dreamed of taking to myself the claim of originality in the matter. It is one of the first things we learn at school in reading of the naval battles of old, the ancient mode of fighting with the ram prow. I was commanding a ship when steam was introduced, and one of the first things that struck us, the young men of those days, was the possibility of introducing the ramming principle through the aid of steam. But there, one soon saw the formation of the ships, and the sail-power unfavourable for the purpose, and that the bowsprit, the cutwater—the two latter were so many buffers to deaden the action of the vessel—whilst the ramming ship would be completely exposed to the raking broadside of the ship attacked. For the time I gave up the idea. It was during the Crimean war, when the French floating battery arrived out—a vessel worked equally under sail or under steam, and at the same time invulnerable;—that it struck me that the moment had now really arrived, when the principle of the ancient ram could be reintroduced. And it was in 1854–5 that I wrote to the Admiralty my views upon the subject, and pressed for a Commission to examine into it.* I shall, however, say nothing more upon that point. With regard to the theory that Captain Colomb has laid down, there is a great deal of excellent good sense in it. It is very necessary that some good theory should be now formed upon the management of fleets and ships and future war tactics, based upon the best materials we actually possess in order to prepare and be in readiness for contingencies before they arrive. The attention of Naval Officers cannot be too constantly kept on the alert on this most important subject. A well based theory once formed, the subsequent perfecting of it becomes a far easier task. I agree also with Captain Colomb that the torpedo is, apparently, a formidable weapon, but when it comes to be brought into practice in actual warfare, there are so many circumstances required to unite, to make it act with certainty, that you could not depend upon it, particularly by the broadside attack. In my opinion no vessel can be better fitted for using the torpedo than the ram, properly constructed. According to my idea, the ram ought to be exceedingly rapid, exceedingly handy; therefore, no other vessel could be better fitted for using the torpedo. In a general naval action it is hardly possible that the torpedo can be depended upon or used with any certainty or safety. You cannot calculate upon the necessary velocity with which the ships must move to apply it in the way that Captain Harvey proposes, particularly if the ship attacked is well armed and swift. I do not say that by-and-bye we shall not come to other modes of using it; but under present circumstances, I think you can never depend with much certainty upon it in a general action. Then, again, I do not think we shall have many fleet actions in the future. The circumstances of former wars, and the blockading of great ports, made it necessary to have a large assemblage of ships to blockade them. But the whole system of naval warfare is now so utterly changed by the introduction of all these new modes of attack, new forms of vessels and guns and torpedoes, that the assemblage of fleets will be unnecessary, and therefore it will be quite a rare chance, the formation of fleets. Our attention ought to be more turned to actions between two or three vessels, or between single vessels, with the ram and with the torpedo vessels if you like. But I think it will be a most extraordinary circumstance if two large war fleets should ever meet again.

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* Sir George Sartorius has requested that the accompanying note may be added to his remarks:—

Extracts from Letters addressed to Sir Charles Wood, now Lord Halifax, in November, 1855.

"Let me earnestly draw your attention to a fact which I have no doubt has pre-
"sented itself to many other minds before, viz., the use of steamers as battering
"*rams* for sinking ships. The successful experiments of iron plated ships has now
"removed all objections to, and renders perfectly safe, simple, and efficacious, this
"mode of warfare," &c., &c. "Let me suppose a steam vessel built without a port
"or a single gun with great longitudinal strength, that being the direction in which
"the blow would be given, with bow built in with massive timber, and the vessel
"covered with iron plates of sufficient thickness to resist that. Then with an
"engine of 1,000 h.-p. at a speed of 15 or 16 knots, could there be a moment's doubt
"as to the fate of the largest ship when the concussion took place?" &c., &c. "If
"the Russians are not able to build these vessels, they will be able to manage it in
"the United States.

"The Confederates carried out exactly these suggestions in the 'Merrimac.'"

Commander the Hon. E. DAWSON: Having of late years turned my attention a good deal towards the manœuvring of fleets, and having had opportunities of observing the practical application of certain theories of fleet manœuvring, I venture to offer a few remarks on the subject of the lecture which we have heard this evening. I would refer first to diagram 6. In this diagram two fleets are represented approaching each other in line abreast. Captain Colomb proposes that A should alter his course in order to avoid the approach of B end-on. Theoretically, certainly, that might appear practicable; but I maintain that any one who has seen two fleets approaching each other end-on, like that, would consider A a bold man if he altered his course as represented in that diagram.

Captain COLOMB: Are you speaking of diagram 6?

Commander E. DAWSON: Yes.

Captain COLOMB: I do not recommend that.

Commander E. DAWSON: That would apply equally to diagram 7. If A was placed in the position shown in the diagram, I cannot think he would ever have the boldness to make a signal to his ships to alter his course simultaneously to starboard, so as to attack the port wing ship of the enemy advancing in line abreast. If he were to advance in a line in which Captain Colomb has originally placed A, I think he would have a much better chance of success. But I do not think any manœuvre is practicable within the space of three minutes, as described in the lecture. Having taken the times of a great many manœuvres, I do not think it possible that any fleet can make any manœuvre successfully under at least fifteen minutes. I do not think it would be advisable for any Admiral to make a signal to attempt to do so. It could only be done by previous understanding with the Captains of his ships. Next, as regards the torpedo, I think at present the torpedo cannot be an efficient weapon for resisting the attack of a fleet or for attack. At the same time, I cannot but think that its power will be very much developed in future years. A fleet attacking in line ahead could not use the torpedo to the same extent as a fleet attacking in line abreast. It is all very well to assume that a fleet in line ahead will pass through a fleet in line abreast. The first ship may succeed in getting through, but the second or third ships would stand a great chance of being rammed by the ship nearest to them; and that would not improbably throw the fleet into disorder. The fleet in line abreast would probably have ships astern on each wing, that would operate upon the ships that pass through. With reference to the *pelotons* or groups, the *pelotons* appear in some ways to be a very good formation. At the same time, I prefer four ships to three. On two fleets approaching, say one in single column in line ahead, and the other formed in groups (pelotons) in line ahead, you may assume that the line ahead will attempt to pass on one side of, and not through the groups, in which case the argument of Captain Colomb would be perfectly correct, that one ship's fire would be lost, provided always those ships kept their stations correctly. But those who have seen fleets manœuvring even in peace time, will agree with me that two ships seldom keep their stations exactly in line abreast. It is very seldom that it is possible to do so; and when you have the smoke of an action, it is quite impossible it can ever be done. Equally so, I may say, more so, with a fleet formed in one column in line abreast. You may lay it down in theory that the ship that passes through the column first will receive the fire of only two ships; but, practically, she will receive the fire of nearer four, because those ships will not be exactly in line abreast as they are there described in the diagram. As regards the torpedoes, I think at present it will not be practicable to work with them; but in future years I am convinced we shall be able to use them much more efficiently than at present; that they will form a great obstacle, and if not a great obstacle, they will be a deterrent to two ships approaching each other and trying to ram each other, because of the fear of a torpedo being towed astern.

Lieutenant **Hubert Grenfell**, R.N.: In addressing you I should like to speak with that modesty which is due from a junior member of the profession. At the same time I should like to express that opinion which I know many members of the profession entertain, I mean the opinion which was expressed by Captain Dawson that these questions of the day should be more thoroughly ventilated, and put in possession of the junior members of the profession. At the present moment we feel a great many difficulties in that respect. We have received a very able lecture to-night from Captain Colomb on "fleet manœuvring." I can hardly say myself how many times these things have occurred to most of us who are working in the same way, but, of course, with inferior opportunities. We wish very much to push forward, as far as possible, the profession to which we belong. I may say that, being out with the combined fleets the other day, when they all assembled for manœuvres, the first question almost which rose to the lips of every Officer who was on deck, when they first saw that splendid array of ships on the horizon, was, how should such a collection of ships be arranged for attack or defence? We were present during the manœuvres, which lasted, for I am sorry we were only present in the detached squadron, for one day; but we saw those manœuvres during the whole of that time. We are thoroughly impressed with the importance of these questions being pushed home, and being thoroughly ventilated. We unfortunately suffer to a great extent from what Captain Dawson still more forcibly put, the want of some institution or some place where these questions of a purely naval character might be discussed. Something has been said about the Harvey torpedo. Captain Colomb himself said that the Harvey torpedo had sunk in his estimation. I think it did so mainly from the fact that experiment had not been sufficiently brought to bear upon the point. I think, also, that the country is committed, to a great extent, to many rash endeavours for the same reason. Inventors seem to think that it is sufficient for an invention to be placed before the country, for the country to take it up; that such an important measure as the whole re-construction of our Navy, which was advocated the other day in the *Times*, was to follow immediately from it. The most rash schemes are put forward in that way. I may mention, having been immediately connected with some experiments with Harvey's torpedo the other day; that, in my opinion, on that particular occasion, it totally failed. We were a whole afternoon trying to ram a small ship, and did not succeed, but had to go into harbour with the torpedo unexploded at the end of it. It was not, as many gentlemen might suppose, that the error was on our side, because gunnery people had nothing to do with it; the experiment was entirely in the hands of the master of a tug, and I am sure no one would take exception to his powers of handling it. Be that as it may, still on the general question of experiments we feel that we really are powerless in the matter. I wish positively and particularly to express the craving for knowledge which exists among the junior Officers of the Navy. There is not that apathy as regards their profession which many suppose to exist. We should only be too happy to learn, but really we have no opportunity at the present day. There are experiments of every nature conducted all round. In the sister service, as Captain Dawson said, there are institutions, there are societies, and there are meetings at which all these questions are discussed. I am sorry to say that in the Navy, which ought to be our "first line of defence," we have nothing of the sort. I do not mean to say that this Institution is not very valuable in its way, but beyond this Institution I think a society ought to exist side by side with it. I do not suppose any difficulty is felt about the existence of the Institution of Royal Engineers and the Royal Artillery Institution. They are very valuable to the country. It appears to me that Captain Colomb, in his lecture has merely dealt with the general question of "fleet attacks;" I think he should not merely do that, but that he should accept the Navy as it is, and develop a system of fleet attacks with the Fleet as it is. This point struck me the other day, viz., the extraordinary diversity of our ships. Mr. Reed specially noticed that point, and, I think, cleverly slipped out of it, because he said he could leave it to the intelligence and ingenuity of British seamen. That is the way the authorities get out of the difficulty. The powers of attack and defence possessed by the Navy of the present day are so widely diverse that it is almost impossible to study and develop the particular powers of every ship. The question of bow fire, of broadside fire, of attack by ram, and of torpedo attack, in connection with each ship, demands, as it were, a special and particular study, so that it is almost impossible to develop a system of tactics which is applicable to the Navy of the present day. In talking about this matter I have met with, I will not say extraordinary opinions, because I should be very sorry to apply such a term to the expressed opinions of Officers who are my superiors; but one Officer advocated attacking in the order of peloton, with Harvey's torpedo on each quarter. All I can say is, that I should be sorry to be in the leading vessel of the peloton, if that is to be the system of attack. I instance that, because it shows the extraordinary crudeness of opinion which exists even in high circles on these matters. I agree with Captain Dawson that after what ought to have been twenty years of definite experiment, we should have had the whole thing at our fingers' ends. I would just mention, perhaps I ought not to mention it here, that at Portsmouth, at our Naval School of Gunnery, we have endeavoured to establish a little society intended to supply these needs. We merely mean to read a few papers on professional subjects, and discuss them, and so forth. I appeal very strongly to members of my profession who may be present this evening to support such a movement, if they think it for the good of the service to do so.

Captain Robert Scott, R.N.: I will only mention one or two points in connection with what Captain Colomb has said, so as not to take up much of your time, because until we have got the results of actual experiments with different ships, there is a great deal of difficulty in deciding upon the best formation for battle. Although I concur with much that Captain Colomb has stated in his valuable paper, I cannot concur in what he says as to the small value of bow fire. I believe a powerful bow fire will be found to be very advantageous, but until we get a diagram showing the actual amount of error in aiming at the hull, and how many hits might be expected in vertical fire, and in firing down upon the upper deck of a vessel (I believe you will have a great deal of plunging fire), you cannot arrive at a just conclusion. In proportion as your guns are large, so will your shot be effective. We know that even at a very small acute angle, heavy steel shot hitting the bow would produce great effect, and if the point is arrested by the shot's biting in the armour, its base is carried forward, and the shot becomes more perpendicular to the plate as it continues to penetrate; but to effect complete penetration of thick armour you require very heavy shot. I would suggest that those who are able, and there are several Officers present to-night who are well able, should get up the subject of the powers of penetration of the different guns, together with a description of the ships, in order that all the facts may be laid before the Institution. By this means we should attain to very considerable knowledge of the value of the different ships of our Fleet, and hence be enabled to come to a much better conclusion as to the mode of using it in action than we can at the present time. As the School of Gunnery has been alluded to, I would remark that instead of being a disadvantage, it would be a very great advantage to the naval service to have a place where the younger Officers could assemble and discuss these questions. Except Captain Colomb there are as yet only one or two Officers who have taken up any of the questions relating to "naval tactics." It would be very advantageous to the profession if some Officer would lay out the models of the different ships here before us, and then show the relative amount of hits that could be anticipated both in bow fire and in broadside fire; this would enable all of us to arrive at a much more definite conclusion respecting the value of the guns than is possible with our present limited information.

Commander Pusey, R.N.: Captain Colomb has stated that the Harvey torpedo has fallen in his estimation. I should like to ask Captain Colomb, if the British Fleet were brought into action to-morrow against a Russian squadron in the Baltic, and he were Commander-in-chief, and he knew that each of the Russians opposite to him were towing a couple of torpedoes whether he would feel himself justified in taking the British squadron into the close action that he has spoken of to-night? My impression is that if he did, and the iron-clad Fleet came to grief, the British public would stigmatise him as the murderer of our seamen. More than that, although the Harvey torpedo has been spoken of slightingly, and has been spoken of as being towed astern of vessels, yet in the experiments I have seen tried with it, the torpedoes have been on the quarter of vessels, and at right angles. I see no reason why the Harvey torpedo, by means of slip ropes, should not be towed from the bows of a ship. Many of us have been towed in a cutter from the paddle-box of a steamer, and gradually we have found ourselves abreast of the paddle-wheel. There is no reason why the Harvey torpedo should not be towed well forward. In that case I maintain that a vessel ramming, or attempting to ram, and missing her aim, would certainly come foul of the torpedo, and would thereby come to destruction. I am only a junior member of this Institution; but I offer these remarks for the consideration of those present, who, of course, will take them for what they are worth.

Captain Colomb: I think I may generally answer the criticisms on my paper in a few words. First of all, I have restricted myself to dealing with what were so far established as facts. I have endeavoured to deal with no fictions. Those who have read my former papers on this subject will see that my opinions have very much changed, and I am quite prepared that they shall change again as soon as new facts are presented to my notice. I wish it to be understood that I take a sort of impersonal view of the question. I have been trying to collect such facts as are obtainable, and to put them together, so as to fit them into some sort of theory of attack and defence, which might set my brother Officers' minds more at work than they are at present. I have not the slightest objection, to use a nautical expression, to "Come up all I have said" about the Harvey torpedo as soon as it is different from what it now is. The state of the Harvey torpedo as it at present exists is, that if it explodes at the water line of an iron-clad ship it is held to be almost harmless. If it is charged with dynamite, or some explosive compound not yet discovered, which, on exploding at the water-line, blows the side of the ship in, the Harvey torpedo will be very different from what it is now. Then it would require less skill to manipulate. Then, as a member said, a fleet towing a number of torpedoes one on each quarter, as he describes, would be very much more dangerous than it is now. As the case at present goes, if I were suddenly promoted, as has been suggested, and were put to attack a Russian Fleet, I should, as far as I can see at present, assume the formation in line-ahead, and go at him, trusting to chance for the rest. At any rate, only one ship would be blown up the first time, to say the worst of it. I quite agree with the general expressions which have fallen from Mr. Grenfell, Captain Dawson, and Captain Scott, about the necessity for experiments. Dealing with the subject as I have dealt with it here, I can only do it most imperfectly, because there are few experiments and few facts to be got. Captain Scott upholds bow fire on grounds which are, doubtless, satisfactory to him, and he deems it much more destructive than I do. Neither of us have any facts to go by; it is simply matter of opinion. If I were dealing with the question myself, the very first thing I would do would be to go to sea to ascertain what the power of the bow-fire actually is. At present we have only some data to tell us that from a sea-going ship firing at another ship, broadside on, at a thousand yards, only about ten per cent. of the shot strike. When we know that that is the effect of shot at a fixed distance, and that ships moving, are altering the range 100 yards in 10 seconds, it seems to me, on the face of it, that without further experiments "bow fire" cannot be held effective. Of course it is hardly relevant to the paper, still we want very much indeed the circulation of even such information as is now to be got. It is most difficult to get information upon any point connected, at any rate, with subjects such as I have been dealing with to-night.

Captain Wheatley, R.N: Captain Colomb stated that the Harvey torpedo exploded at the water-line. I know Captain Harvey, and I know he intended his torpedo to explode some feet under water, and then it is most formidable. I think, therefore, there must have been some mismanagement if it exploded at the water-line.

The Chairman: I have no doubt that the meeting will depute me to return our most grateful thanks to Captain Colomb for his valuable paper. He has frequently come before us on questions affecting our own profession. I should very much like to see these experiments carried out. I was delighted to hear the speech of the gallant young Officer (Lieutenant Grenfell), and to learn that the junior Officers are starting a society at Portsmouth for the discussion of professional subjects. If it were not so late I should like to have asked him whether, in the projected college at Greenwich, he thinks they will be able to carry out all these experiments in tactics and with torpedoes, which some writers in the *Times* suggest should be made in the Thames! I only hope that before it is finally determined to establish a Naval College at Greenwich, the Admiralty will duly weigh all the advantages which Officers, who have studied at Portsmouth, have found there. The college is in the dockyard, where most of the new ships can be seen from time to time, and near the "Excellent," where our gunnery instruction and experiments are carried on, and we are there among many of our brother Officers, both on shore and afloat, with whom we can discuss naval matters somewhat in the same manner as these young Officers propose to do; thus we have many means of acquiring professional knowledge, which will clearly not be available at the proposed Naval College at Greenwich.

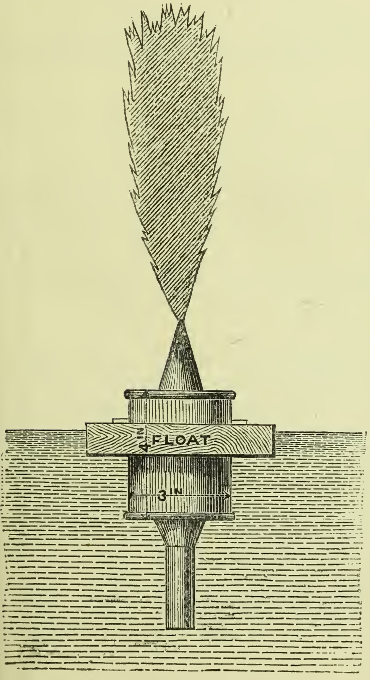
HOLMES'S "STORM AND DANGER SIGNAL-LIGHT."

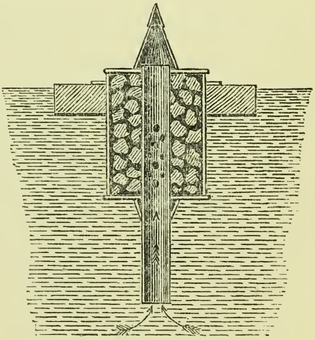
By Mr. NATHANIEL HOLMES, Electrical Engineer.

AT this late hour, I can do no more than bring before you a short explanation of a new "signal-light" which may be applied to many very useful purposes in the Navy and also in the Army. The peculiar properties of this "signal-light" are, that it is non-explosive; it is not affected by heat; you may throw it into the fire; you may melt the case, but you will not injure the composition that is inside the case. It is not affected by concussion; friction does not in away damage it. It is not affected by anything but by water. If you throw it into water it bursts into flames spontaneously, and burns with a most brilliant light for a considerable length of time. The small "signal-light" which I hold in my hand, will burn for nearly two hours; it will give a very brilliant light for forty-five minutes, and neither wind nor water will put it out. For use in connection with marine purposes I need hardly explain its many advantages. It is now adopted and in use by the Peninsular and Oriental Steam Navigation Company; by the Messageries Maritime Imperiales; and by most of the large lines of deep sea steamers. The Royal National Life Boat Association have also had some of these "storm-signals" supplied to certain of their stations for experiment. At sea it will be found invaluable. Suppose a man falls overboard, all that has to be done, is to take a knife, cut the top off the pointed end of the case, pierce a hole in the end of the bottom tube, throw the signal into the sea, when it immediately flames up and marks the spot where the man has fallen, while the boat is being lowered, and the vessel brought up in her course. If the man can swim, he swims to the light, and the boat pulls to the light; it becomes the rendezvous where to pick him up. That is one very important use of this "signal-light" at sea. By means of it, the position of a ship's boat in a dark and stormy night is accurately ascertained, and the frequent, tedious, and at times unsuccessful groping about for hours to find her, is avoided. Incidents of this kind are of frequent occurrence. Another use at sea is where the light is placed in a small water reservoir, and used about deck as an open lanthorn for furling sails on a dark night, or for the purpose of lowering over the side of the ship in cases of fouling anchor-chains, accidents, or repairs, or at the masthead as a "flash-signal." The light at its maximum is so intense, that it may be seen for thirteen nautical miles from a ship's mast. With your permission I will now ignite one of the lights, first explaining its construction and composition; the principle of its self-ignition will then be understood.

The case is composed of a stout tin cylinder 3 inches in diameter and 4 inches high, from the lid of which a conical brass burner projects, the perforated apex of which is hermetically closed by means of a soft metal-cap soldered securely on. Through the bottom of the cylinder, a metal tube, 1 inch in diameter, passes into the interior of the case, to within ⅛th inch of the upper lid, which carries the cone. The portion of the tube within the case is perforated with holes, while the tube projects outside the case 3½ inches. The opening at the bottom of the tube is likewise hermetically sealed by a soft metal-cap. The interior of the cylinder surrounding the perforated tube is filled with the chemical ingredients.

The chemical material contained inside the "signal-light," consists of common chalk broken into small pieces about the size of bits of lump





sugar; these chalk-lumps are then heated to a white heat in a crucible containing a certain proportion of phosphorus, which being converted into vapour by the high temperature, is absorbed by the chalk when at a white heat, much as a sponge absorbs water. The chemical material thus formed (phosphate of calcium) is, when cool, placed in the signal-light-case, and the whole soldered down air-tight.

All that is required to be done, when the signal is needed for use, is with a knife to cut off the soft metal-top exposing the perforation in the brass cone for the escape of the gas, and by piercing the lower soft metal cap, to make an opening to admit water into the body of the case. On placing the signal in water, the flame immediately bursts forth, the water coming into contact with the chemical ingredient through the perforations in the inner tube. This signal-light has already been approved of by the Board of Trade for use at sea, as a substitute for blue-lights and port-fires, and some experiments have recently been made by Mr. Thomas Gray, the Secretary of the Marine Department of the Board of Trade, with a view of ascertaining how far the light could be employed in cases of shipwreck as a means of assisting the rocket-line-apparatus, by being projected in the form of a shell from the ordinary 5½-inch mortar. These experiments, suggested by Mr. T. Gray, were quite successful, the signal light being uninjured by the percussion, and blazing away on falling into the water. I place on the table the form of the light and shell to be employed for projection into the sea from the 5½-inch mortar; the two extremities of the case are of course pierced before it is fired from the mortar.

The third form of the "signal-light" on the table is, one to be used as a powerful flash and danger-signal for lifeboat services; it is contrived to produce a very powerful light for a shorter length of time; it burns for fifteen minutes or more. This modification of the signal is made, as it has been sometimes urged as an objection, that it burns too long, and cannot be extinguished. In this form there is a larger surface of the chemical material exposed to the water at the same time, more gas is therefore given off, and you obtain a brighter flame; but it burns for a shorter period.

Mr. Holmes then exhibited the mode of using the lights; two signal-lights were selected, the tops cut off, and openings made in the bottom. One was plunged under water, the other was floated on the surface, and the moment the water came in contact with the composition, a brilliant flame burst forth from each signal, and continued to burn for a long period with increasing intensity. In the case of the signal under water the flame rose to the surface, not in a continuous stream, but in a succession of gulps as it were, while the light from the signal on the surface of the water burned with the steadiness and force of a strong gas flame. The only drawback to the experiment in the room was the quantity of vapour which the lights emitted during burning. At sea this is considered an advantage, from the smoke being illuminated by the flame and seen at an immense distance.

Admiral Ryder: How long does the flatter form of signal light burn?

Mr. HOLMES: The flatter form burns about fifteen minutes with an intensely bright light. I may state that this signal light has been taken into custody twice; once at Inverness last July, when it was exhibited before the Railway Clearing House officials, and once at Brighton, when it was exhibited before the Emperor of the Brazils, the Coast Guard thinking it to be a signal for some illegal purpose.

Captain WILLES, R.N.: Does damp injure the light?

Mr. HOLMES: No, the case is perfectly air-tight, and water-tight.

Captain COLOMB, R.N.: About the storage on board ship?

Mr. HOLMES: There is no danger, and besides there is little heat in the flame; it is warm, but there is not very much heat.

Captain COLOMB: But if through damp it caught fire?

Mr. HOLMES: It cannot catch fire from damp. If it becomes damp you will perceive a disagreeable odour. Nothing but water will set it alight. Dampness will only decompose the material.

Captain WILLES: How about it if it is in a hot damp climate for six months?

Mr. HOLMES: The greater the heat, the safer the storage of the light. The damp will not affect it. Some of these lights I have kept under water three months; they are all carefully tested before they are packed, and sent out from the works.

Admiral RYDER: What is the intensity of the light as measured by gas candles?

Mr. HOLMES: It is considered to be about thirteen times the illuminating power of ordinary street gas; but I must confess to a little ignorance upon the precise relative illuminating power, for I have been so busy that I have not had time to compare it with more than the ordinary blue light at a mile and a half. This light has been burned and the blue light has been burned at the same distance. The comparison between them is remarkable. In a shipwreck, you often cannot light your blue light from damp and water, but with this signal light you are independent of the sea washing over your boat: the more water, the more light; it is inextinguishable as we have seen by water, and wind cannot put it out, though it may partially separate the continuity of the flame. With regard to the expense, I consider the expense of this light to be one-half the expense of blue lights, which are about 14*s.* a-dozen; the price of these lights is 6*s.* each; but then from one signal-light you obtain a better light, which will burn for 45 minutes, and have a light independent of water washing over it. I question whether the whole dozen blue lights would burn for 45 minutes; certainly not if they get wet. This light has been tried at Shoeburyness, under the direction of Mr. Thomas Gray, and fired out to sea, a distance of about 840 yards, from a 5½-inch mortar, with charges of 3½ and 4 ounces of powder, to see if concussion would destroy the igniting power of the light.

A VISITOR: Has the light been used as a flashing signal?

Mr. HOLMES: No, it has only at present been adopted by the Peninsular and Oriental Company, and other important lines of deep sea steamers; but I consider, when it becomes better known, that it will prove to be invaluable for certain purposes connected with Naval and Military tactics; for instance, as a signal light for the protection of torpedo lines, when flashed by a reflector across the range; for deceiving an enemy at night by false signals; for discovering what is being done under cover of darkness by an enemy's boats, by projecting these lights into their position; for protecting a shore or battery from surprise at night, by means of their illuminating power; for target practice at night; for marking the position at night of buoys, and for laying down torpedo-bearings at night; and for all other such purposes whenever a powerful light is required out of doors, simple, portable, and free from danger in transit. For military purposes it may with equal advantages be applied to pontoon-bridge building, trench work, fortification defences, camp equipments, horse picketing, and flash signals for special manœuvres, and also for balloon signals; its extreme lightness and security enabling any and every soldier to carry one or more when engaged upon special service. For shipwreck it is equally useful. Three or four thrown upon the sea will illuminate the surrounding darkness, and enable the shore rescue parties to direct their endeavours in the most practical manner. At such times the value of a brilliant inextinguishable light is beyond belief; it means the saving of many lives.

The thanks of the meeting were then voted to Mr. Holmes for exhibiting and explaining his signal-lights.

Evening Meeting.

Monday, January 22nd, 1872.

MAJOR-GENERAL F. EARDLEY-WILMOT, R.A., in the Chair.

NAMES of MEMBERS who joined the Institution between the 16th and 22nd January, 1872.

LIFE.

Wallace, Charles T., Capt. 74th Highlanders.
Poignand, George, Lieut. 59th Regiment.
Maitland, E., Capt. R.A.
Norton, Cecil W., Lieut. 5th Royal Irish Lancers.

ANNUAL.

Dobbs, F. G., Lt. 1st Middx. Art. Vols.
Crookshank, Alex. Crowder, Assist.-Controller,
Shervinton, C. R., Lt.-Colonel Unatt.
Lyons, Algernon McL., Capt. R.N.
Campbell, George, Lieut.-General, C.B., R.A.
Bushell, John M., Comdr. R.N.
Maldon, Viscount, Lieut.-Colonel Herts Yeo. Cavalry.
Price, Arthur, Paymaster, R.N.
Tufnell, Edward, Lt. 18th Royal Irish.
Clayton, Thomas, Paymaster R.N.
Mayers, J. P., Colonel late 86th Regt.
Herdman, Alfred, Lieut. 5th Royal Irish Lancers.
Mortimer, Stanley, Capt. late 60th Rifles.
Dashwood, Geo. J. E., Lieut. Scots Fus. Guards.
Blane, Gilbert Gordon, Lieut. Scots Fus. Guards.

THE EMPLOYMENT OF MITRAILLEURS DURING THE RECENT WAR, AND THEIR USE IN FUTURE WARS.

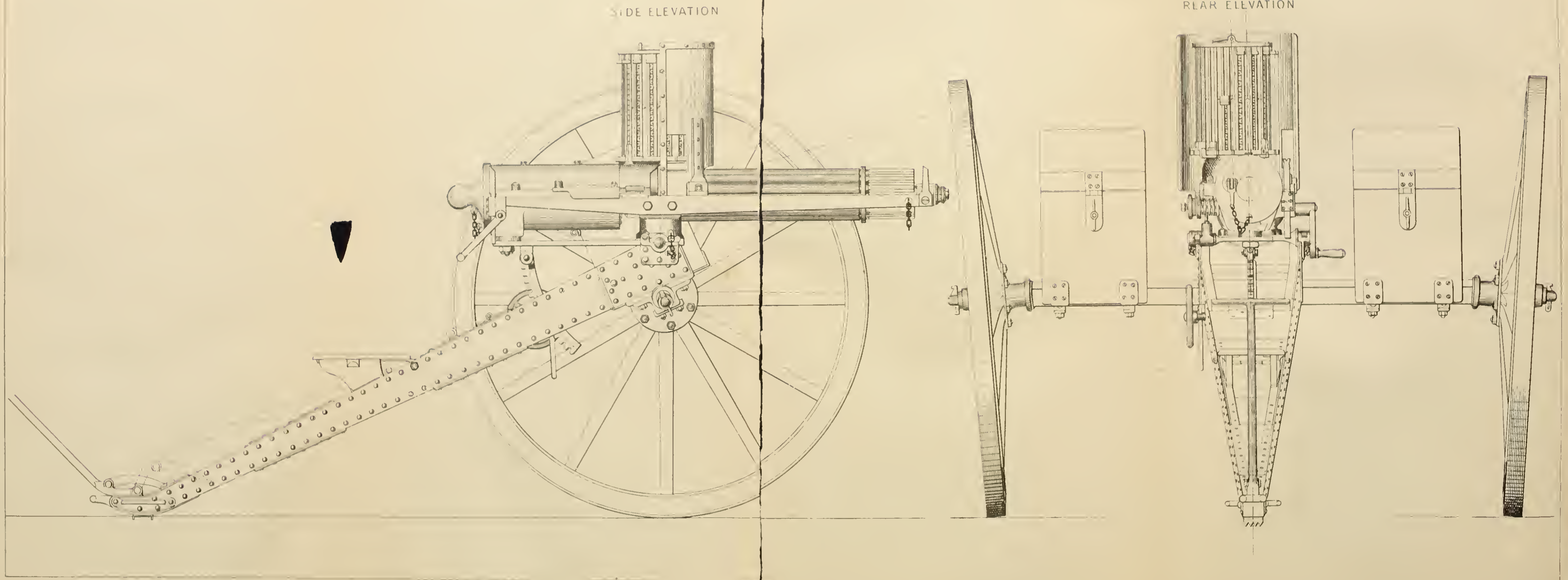
By Lieutenant-Colonel H. C. FLETCHER, Scots Fusilier Guards.

THE CHAIRMAN: Colonel Fletcher, of the Scots Fusilier Guards, who is to read a paper on the "Employment of Mitrailleurs during the recent War and their Use in future Wars," is known to most of us; and to those who do not know him, I may say that he has been long distinguished as an able and zealous Officer; and that, as a member of the Committee on the subject on which he is about to speak, he has had ample opportunities of making a thorough investigation of the merits of the mitrailleur. Whatever he says, I am sure, will receive careful consideration.

Colonel FLETCHER: In bringing before your notice the subject of the employment of the Gatling-gun in war, I wish it to be understood

0·45 INCH GATLIN GUN & CARRIAGE.

Sca 1/12



J. Jobbins

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that I have little or nothing to say that is original, and have no dogmatic opinions to offer, founded either on carefully-constructed theories or on extended practice. I have merely endeavoured to collate from various documents, and especially from the reports of the War Office Committee, of which Colonel Wray is President, and of which I have the honour to be one of the members, the opinions for and against the employment of this description of weapon, and the reasons deduced from the examination of oral and written evidences for its adoption into or rejection from the category of military arms.

The mechanical construction of the gun has been already carefully described in a paper contributed to this Institution by Mr. Gatling (see vol. xiv, p. 504, *et seq.*), and if not already understood, will readily be comprehended on an inspection of the drawings kindly placed at my disposal by the Secretary of State for War;* and on examination of the gun itself, also lent to the Institution for the purpose of illustrating this paper.

The subject of the employment of mitrailleurs in the wars of the future has also been very ably dealt with by Major Fosbery, 𝔙.ℭ., in a paper communicated by him to this Institution (see vol. xiii, p. 539, *et seq.*); and the only excuse I can offer for again bringing it before the notice of the members of this Institution, lies in the fresh light that has been thrown on the merits or demerits of the mitrailleurs during the recent campaigns between France and Germany, where they were for the first time extensively used, and from the fact, regretted by Major Fosbery, that his lecture was not followed by a discussion, which would probably have elicited some valuable opinions. On these grounds I have ventured to re-open the subject, and with that view purpose to lay before you a summary of the several arguments for and against the adoption into the Services of the machine gun, embracing generally under that name, the Gatling, preferred by Colonel Wray's Committee, and the French mitrailleurs.

The idea of machine guns is not new; weapons somewhat resembling in principle the present Gatling-battery, were manufactured in the early part of the sixteenth century. They were known as "orgues" or "orgels," and the term is thus defined by M. Remi in his "Memoires de l'Artillery." "An orgue is a machine composed of several musket barrels "fastened together, and used for the defence of breeches and entrench-"ments on account of the possibility of firing from them many shots "at once." Of these "orgues" specimens still exist in Germany. They are specially mentioned by Weigel in his description of the arsenal at Nuremburg, in 1698, and are called Todtenorgels, on account of the deadly power of the thirty-three barrels of which each were composed.†

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* The Institution is indebted to Sir William Armstrong and Co. for the accompanying plate of the ·45 Gatling-gun with the latest additions and improvements. —Ed.

† Since writing this paper, the author's attention has been called by Captain H. Brackenbury, R.A., to the employment of weapons somewhat resembling in principle the mitrailleur as early as the year 1382. They were termed ribandeause or ribauldequins, and were used by the men of Ghent in their attack on Bruges.

Probably, as was the case with the revolvers of that early period, defects in manufacturing skill prevented their perfection; whilst, although some of them appear to have been loaded at the breech, no attempt was made to secure continuity of fire, such as is possessed by the modern Gatling-gun. In another and most important respect, the old machine guns were defective. The method of inserting the charge in rigid cartridge cases was unknown, and, as Major Fosbery points out, the serviceability of this description of weapon has mainly resulted from the adoption of the metal cartridge-case of comparatively recent invention.

It is not, however, with the history of mitrailleurs that I propose to deal; allusion to it was necessary, first, to show that these arms were known to our forefathers, and were by them recognized as serviceable for certain military purposes; and, secondly, to meet the objection which might be raised against them, that they have never played a prominent part in former wars, by pointing out that although the principle might have been recognized, its application was defective.

The real point at issue is, whether the best form of machine gun, which, assuming the Report of Colonel Wray's Committee to be correct, is that known as the "Gatling," is a weapon which ought to find its place in modern warfare. That it possesses fearfully destructive powers, no one who has ever seen it fired, can doubt; but whether it should, in accordance with its greatest admirers, take the place of the lighter artillery, whether it should supplement that arm, as some who are more moderate would recommend, or whether it should be cast aside as a curious but comparatively unserviceable weapon, as others would urge, are the questions that I would desire to present to you for discussion this evening.

In order to form just conclusions on this important subject, a knowledge of the grounds on which the admirers and opponents of the mitrailleurs (to use the term as embracing the principle) found their opinions, is essential; and, therefore, I propose to endeavour, first, to place before you in a few words the alleged reasons for and against their extensive introduction into the Services, and then to try to prove how far these reasons have been justified by the experiences of the late war.

To commence with the opinions of those most in favour of the arm, Major Fosbery in his paper (before alluded to) when advocating the adoption into our Services of the Montigny mitrailleurs, sums up their advantages and disadvantages in comparison with field artillery. He commences his argument by laying down the broad principle, that in war as in peace, machinery should, as far as practicable, take the place of human labour. "If," he says, "it be possible, by means of a "machine, not too liable to derangement, and not too complicated "for the comprehension of the soldier, to make three or four men do "the work of 120, the advantage must be self-evident." Granting this hypothesis, it remains to be shown whether the result claimed has not already been attained by artillery, and whether, if guns are still further to replace men, an increase in field artillery would not fulfil the desired object.

Major Fosbery considers that room exists for the employment of an intermediate weapon between infantry and artillery, and infers that at the shorter ranges, the mitrailleurs will be a more certain, and, consequently, more effective arm than field guns. He instances the experiments made before the *Segment and Shrapnel Shell Committee* in 1869, where, to judge from the report, the results of artillery fire against infantry — but feebly entrenched—was remarkably slight, and where the numerous faulty rounds, consequent generally on defective fuzes, showed that there are in artillery fire important elements of error, irrespective of inaccuracies of aim. Greater rapidity of fire is claimed for the mitrailleur as compared with the field gun, measuring that rapidity by the number of shots compared with the number of pieces of segment, or bullets in shrapnel; and if at the longer ranges, say at 1,400 or 2,000 yards, the advantage lies with the field gun, at ranges under 1,200 yards the conditions are, by Major Fosbery, believed to be reversed. The mitrailleur if exposed to artillery fire at the longer distance, would, consequently, probably be knocked over, whilst if approached by that arm within its effective range, it would inflict serious injury on the horses and gun detachments.

Mr. Gatling, in the paper before referred to, presses the utility of his invention to a point beyond Major Fosbery. He advocates powerful long range Gatlings to compete with field artillery, and thus sums up their advantages:—

1. Equal range, and greater accuracy and precision than field-guns.
2. Rapidity and continuity of fire, viz., 200 shots per minute, each bullet weighing a half pound.
3. No re-sighting or relaying between each discharge, there being little or no recoil.
4. Lightness.
5. Greater power of ricochet fire.
6. Economy in money, in horses, and in men.

In his pamphlet Mr. Gatling still further urges the claims of his gun in comparison with infantry. He considers it as the means of revolutionizing in a great degree the present modes of warfare. A few men furnished with these death-dealing engines will, according to his opinion, be able to defeat thousands armed with ordinary weapons; consequently their use will, in a great degree, supersede the necessity for large armies.

He considers the accuracy of the Gatling fire will, shot for shot, be much greater than that of the infantry, on account of its greater steadiness, and its want of nerves, whilst the exposure of life, owing to the small number of men necessary for the service of the gun, will be comparatively very slight.

Having thus briefly alluded to the opinions ably set forth by Major Fosbery and Mr. Gatling, I propose to detail the reasons, founded on experiment, which induced Colonel Wray's Committee to reject for land-service, the larger Gatling-gun, and to recommend the smaller arm, throwing a bullet of similar size to that of the new army rifle.

In their report of the 28th October, 1870, the Committee point out the difference of opinion which existed as to the value of these arms in Prussia and in France, the former being adverse to them on the ground that the narrow sphere within which their effect was restricted did not compensate for the *personnel* and *matériel* required in serving them, whilst the latter, taking a different view, adopted the mitrailleurs in comparatively large numbers. The Committee then justify their preference for the Gatling over the Montigny, and having selected the former, state what they consider to be their uses in warfare. As this part of the report summarizes generally the opinion of those who hold a moderate view on this disputed question, I think it well to read it *in extenso* :—

Extract from the Report of Colonel Wray's Committee.

"The results of the recent enquiry have fully satisfied the Com-" mittee of the expediency of introducing a certain proportion of these " machine guns, to act as auxiliaries to the other arms of the service; " and, of the several designs which have been submitted for their con-" sideration, including those that have been under trial, they are per-" suaded that the Gatling-gun is the best adapted to meet all military " requirements.

"To assist in defending such positions as villages, field entrench-" ments, &c., the Committee feel satisfied that the small Gatling would " be found invaluable.

"For the defence of caponnières, for covering the approach to " bridges or *têtes-de-pont*, for defending a breach, and for employment " in advanced trenches or in field works, where economy of space is of " the utmost importance, the same sized Gatling would unquestionably " be a most effective weapon.

"For naval purposes, the small Gatling would apparently be well " adapted for use in the tops of vessels-of-war, to clear the enemy's " decks, or open ports; while for gun-boats that carry only one heavy " gun, and for boat operations, the medium sized Gatling would be " most effective in covering the landing of troops, or for service up " close rivers.

"The Committee are also impressed with the effect produced by the " medium sized Gatling, 0·65 inch calibre, at long ranges as compared " with that of a field gun, but looking to the weight of ammunition " required to produce this effect, and to the exceptional conditions " under which the larger Gatling could be used with advantage in the " field, they are satisfied that a gun is far preferable at long ranges, " and, consequently, they do not recommend the introduction of the " larger description of Gatling for land service.

"In advocating the introduction of the small Gatling-gun, the " Committee wish it to be distinctly understood that they do not for a " moment contemplate their supplanting or displacing a single field " gun, the proportions of which have been laid down by the best " military authorities, as indispensable for an army in the field.

"The characteristics of the two weapons are essentially different.

" Except against an enemy in the open, the fire of a mitrailleur is com-
" paratively worthless, whereas artillery fire will search out an enemy
" from almost any position, whether covered by trees, brushwood,
" earthworks, or houses, and at distances far beyond the range of a
" mitrailleur; but, in the open, and at distances up to 1,200 yards,
" there is reason to believe that the latter will be found the more
" destructive, owing to the rapidity and continuity of its fire."

This report resulted from an examination of the trials which were from time to time conducted in the year 1870 between the Gatling and the Montigny, and between these mitrailleurs as compared with infantry and artillery. The Committee which submitted it was composed of Colonel Wray, an Artillery Officer, as President; an Officer of the Royal Navy; one from the Royal Engineers; three Artillery and one Infantry Officer. Thus, although preponderating in numbers, the artillery element was counterbalanced by representatives from other branches of the professions. The experiments clearly showed the deadly effect of the fire of the smaller Gatling at ranges up to 1,400 yards, whilst the larger and medium guns gave good results at ranges up to 2,070 yards.

From a comparison of a series of eleven trials of the small size Gatling, of the 9-pounder muzzle-loading field gun firing shrapnel, and of the Martini-Henry rifle fired by six guardsmen, at ranges from 300 to 1,200 yards, and under various conditions in regard to time and known and unknown distances, I find that the Gatling made 2,699 hits, the 9-pounder muzzle-loader 1,620 hits, and the Martini-Henry 718 hits, *i.e.*, the Gatling was about $3\frac{2}{3}$ times and the 9-pounder $2\frac{1}{4}$ times more effective than the Martini-Henry in the hands of six soldiers, a result I would venture to term satisfactory as regards infantry fire. Not that I mean to affirm that this comparison is a true measure of the efficiency of the 9-pounder and Gatling as compared with infantry. To say that the fire from a field gun was only equal to that of fourteen infantry, and that that of a Gatling was not more deadly than the fire of twenty-two infantry, and to measure their efficiency in the field by this standard, would lead to very erroneous conclusions. Each arm I contend has its own duty to perform, and there are moments in battles when no field gun or Gatling would counterbalance the absence of even a section of infantry, as there are times when a single shell from a 9-pounder, or a volley from a Gatling, would be worth more than the presence of a battalion.

Notwithstanding these trials, the opponents of the mitrailleur, whilst admitting its exceptionably deadly fire, maintained that its introduction into modern armaments was a retrograde step. They alleged that only a certain proportion of guns, laid down broadly as $2\frac{3}{4}$ per 1,000 infantry and cavalry, could accompany an army in the field. That an increase in the number would unduly augment the "impedimenta," would block up the line of march, and would probably be found impracticable to manage in action. Consequently, as it would be undesirable (taking the views of the Committee) to diminish the field artillery, the addition to this arm of mitrailleur-batteries would unduly add to the wheeled transport, and prove an incumbrance to an army from the increase in the number of horses which would require feeding. Supposing modern warfare should permit of an addition to the number of wheeled armaments, the opponents of the mitrailleur consider that the artillery should be increased rather than be supplemented by machine-guns, as, although in experimental practice at the shorter ranges, the Gatlings have proved more deadly than any description of shot or shell when fired against representation of troops in the open, yet that the field-gun has by far the longer range, and has greater scope in its powers, being useful against entrenchments as well as against men. They affirm that field guns will be able to destroy the mitrailleurs whenever they venture to show themselves, and that no hail of rifle bullets can equal in moral effect the fire of shell from artillery. They also say that the range of the field-guns can be more easily tested by trial shots than the range of the Gatling.

Such, given shortly, are the opinions of those who oppose the introduction of the mitrailleurs into the military service.

Its modified acceptance by the Navy does not appear to have provoked so much opposition. The report of the Naval Committee assembled, in 1868, at Washington, confirms the opinion expressed by Colonel Wray's Committee, of which Captain Foley, R.N., was one of the members. The Report, as quoted by Mr. Gatling, states as follows:—" The American Naval Officers consider it serviceable " as an auxiliary arm for special service, to be used from top-gallant " forecastle, poop decks, and tops of vessels of war, and in boat operations against an enemy, either in passing open land works or clearing " breaches and other proposed places for landing from boats, &c. If " opposing infantry and cavalry it has no known superior, its great " merit consists in its accuracy within the limits of its range; the certainty, and if need be, rapidity of fire, with the additional merit of " only requiring three persons to load, direct, and fire each piece, when " suitably mounted, afloat or ashore." It has also been suggested that the Gatling will be found useful in firing into the ports of vessels of war attempting to pass forts, which owing to the narrowness of the channel, they may be forced to approach within close range.

Whatever opinions may have been held on these weapons, their practical employment in war should be the true test by which to judge of their efficiency, provided that the arms themselves are good and their proper use understood. Until the recent campaign in France, no opportunity occurred of testing their presumed merits. " Machine-guns," somewhat resembling the Gatling, were indeed exhibited to General M'Clellan during his campaign before Richmond, in 1862; they were called somewhat contemptuously coffee-grinders, and were not brought to the front. The army already possessed an undue proportion of artillery, and the wooded country in which its battles were fought, was not favourable to the use of this description of gun, supposing its mechanism to have been sufficiently perfected. Consequently the "machine-guns" remained untested, and were not subsequently brought into use during the later campaigns of the American war;* neither were they employed during either the Danish or Prusso-

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* A weapon with twenty-five barrels, resembling the mitrailleur, was employed, in 1863, in the attack on Fort Wagner.

Austrian wars, and it remained for the French War Department to ensure to them their first practical trial.

Partly from a belief in their merits, partly to raise the *morale* of the troops, and to counterbalance the prestige of the Prussian Army, fresh from its victories over Austria, the French military authorities unduly exalted the advantages of the mysterious engine hidden in their arsenals. Terrible stories of its destructive powers were allowed to leak out, and every method was taken to rouse the confidence of the troops in the new weapon which was to revolutionize war. On the 1st of July, 1870, the Army was provided with 190 mitrailleurs.

At the first skirmish, viz., the affair before Saarbruck, the mitrailleur was brought to the front and shared with the Prince Imperial the honours of this short-lived success. The events that followed were so awful, and the defeats of the French Army succeeded each other so rapidly, that opportunity did not offer of examining critically the employment of any particular arm. Now and then, among the many accounts of these battles, anecdotes of the mitrailleurs are narrated, sometimes mentioning them derisively, at others alluding to the deadly effects of their fire, and summing up with the enumeration of the numbers captured at the successive surrender of the French armies.

Feeling the importance of investigating the truth of the many statements which were put forth on this important question, Colonel Wray's Committee decided on taking evidence from Officers who had been witnesses of some of the engagements, although unfortunately, owing to the veto put upon the presence of English Officers with either army during the earlier campaigns, little direct information as to the employment of the mitrailleurs previous to the battle of Sedan, could be obtained. The evidence, therefore, relates principally to the later actions fought on the Loire. Time will admit of but a short summary of what was given before the Committee, but should anyone desire still further to investigate the subject, he has only to read the evidence in full. The effect of the French mitrailleurs (for, excepting in one Bavarian corps, none were brought into the field by the Germans) was witnessed by several of our Officers on different occasions, and has been alluded to by more than one writer on the war.

Thus Colonel Rüstow speaks of a mitrailleuse battery of Douay's division being in action for a short time at the battle of Weissenberg, when its ammunition waggon was struck by a Prussian shell and blown up, wounding so many of the gunners that it was forced to withdraw, not, however (if one may judge from the accounts of those who have inspected the field of battle), before it had inflicted heavy loss on the advancing infantry.

In a book entitled "From Sedan to Saarbruck," by an Artillery Officer, the effect of the fire of six mitrailleurs at the battle before Sedan is thus narrated. The guns were entrenched, and played with deadly effect on the Prussians who attempted to cross a valley intervening between them and some rising ground about 900 yards distant. The author writes, "that the numerous Prussian graves on the slope "of the Mamelon attest the severe loss they suffered, and," he adds, "in this solitary instance the effects of the mitrailleurs were con-

"fessedly superior to any which could have been inflicted by common "shell." He further quotes the opinion of a Prussian Officer given to him personally, which appears to be in accordance with that of the generality of the German Officers during the War. This Officer admitted that the effect of the mitrailleur against solid masses was good; but he considered them comparatively harmless against troops in line, under which circumstances their action might be likened to a charge of unscattered swan shot, merely riddling two or three men. It is fair to say that this defect in the French mitrailleur has been remedied in the Gatling, in which the traversing arrangement permits of a wide sweep of the shots during the very process of firing.

Mr. Winn thus describes the effect of the mitrailleurs on a body of cavalry at the battle of Gravelotte:—"It was about 3 o'clock that "Malmaison was taken by our (meaning the German) troops, and "it was on some Uhlans, who tried to cut off the retreat of some Voltiguers from it, that the mitrailleur so terribly vindicated its "character for destruction. A squadron rode forward with its usual "pride and confidence; we heard the growl of this truly infernal "machine; we saw an unwonted confusion in the Lancers' ranks; they "wheeled, and retired, leaving behind them 32 horses and as many "men. They had unwittingly crossed the fatal line of fire; and had "they waited to rescue their comrades, three minutes would have "sufficed to the French artillerymen to put them in the same helpless "condition. We had gone forward to the extreme point on our side "of the glen, and with our glasses could plainly see the gunners as "they placed the fatal plate in the hydra-mouthed cannon."

Colonel Fielding attached great value to the mitrailleur, and instanced the effects produced on a Prussian column of infantry at the second battle of Beaugency, where clear gaps were cut through one of its angles. The same effect, he thinks, could not have been produced by infantry, as the time necessarily spent in deployment would have given warning to the approaching column. "He looked upon "the proper use of mitrailleurs to be as representing a certain number "of infantry, for which there is not room on the ground, suddenly "placed forward at the proper moment, at a decisive point, to bring a "crushing fire upon the enemy." He also prefers placing them in defensive positions "where the front is restricted, and where it is necessary while keeping up a proper amount of fire to the front, to economise space."

On three different occasions Colonel Reilly, C.B., R.A., saw the mitrailleurs used against troops who were taking advantage of the undulations of the ground to obtain cover, and on none of these occasions did he notice the loss inflicted by them to have been great. On the other hand, although the mitrailleurs were standing in the open, exposed to the fire of the Prussian artillery for four and a half hours, no injury was done to them by shot or shell. At Beaume le Rolande, the French did good service in street fighting with the mitrailleurs, but on the whole, Colonel Reilly evidently considered that artillery would have been more efficient, and that the extra wheeled transport entailed by this description of armament, did more harm than good to the French Armies. He also states that the Prussian Officers were greatly opposed to incumbering infantry regiments with mitrailleurs, even supposing they were introduced into their service.

Captain C. B. Brackenbury, R.A., who was present with the Army of Prince Frederick Charles, narrates that upon the only occasions when he witnessed any serious effect from the mitrailleurs, three of them succeeded in stopping the advance of the German troops who had hitherto faced the fire of the artillery. These three mitrailleurs were subsequently captured by skirmishers detached from the main body, who took them in flank. He considers their fire to be superior to that of infantry, because an infantry man has nerves, which will probably be disturbed when he is exposed to fire, whereas the machine has none.

Captain Hozier formed opinions similar to those of Captain Brackenbury. He saw mitrailleurs employed in the sorties from Paris, and at Le Mans, where the supports of a line of skirmishers suffered from their fire; the skirmishers, however, advancing beneath them, and avoiding their direct discharge, closed in, and captured them. By this method the mitrailleur batteries were usually taken, their infantry supports retiring and leaving the guns to their fate. On the whole, Captain Hozier concurs in the opinion of the Prussian Officers with whom he conversed, that for field service the horses and men necessary for the mitrailleurs could be better employed with artillery, but that for entrenched positions, for narrow roads, and for the ditches of fortresses they were and would be most valuable. Prince Frederick Charles expressed a preference for twelve or thirteen infantry soldiers instead of a mitrailleur, as they would be less liable to be destroyed by a bursting shell, and their fire would be more accurate.

Captain Gurdon, R.N., who witnessed the later campaigns on the French side, entertains a high opinion of the efficiency of the mitrailleur fire. He saw them employed against infantry columns, and on one occasion against field batteries, which were compelled to retire, owing to a loss of horses. He considers them quite indispensable in warfare at the present day, but does not agree with the French in their method of employing them. They are adapted, he believes, for defence rather than for attack, and are especially suited for protecting gorges or defiles, and for street fighting. The French mitrailleurs he considers to have been too heavy, as four horses were required for the gun alone. The weight of the guns, or rather their increased charges, seem to have given range, as, according to Captain Gurdon, they were most efficient at from 1,800 to 2,300 yards.

Captain Henry Brackenbury corroborates much that was said by Captain Gurdon, but reduces the effective range of the mitrailleur to about 1,000 yards, possibly alluding to a weapon of less calibre. He had the advantage of noticing their destructive powers when well placed, and their inefficiency in the hands of those who were ignorant of their proper use. The description he gives of the battle of Sedan presents so vivid a picture of mitrailleurs when well handled, that I hope I shall be excused if I quote it from his evidence. "Two or

" three days after the battle of Sedan, I was (he says) on the field: " they had not long finished burying the dead. I was very much " struck with the number of graves at one point, just between Douzy " and Bazeilles. I made enquiries, and was told that great havoc had " been committed there by some French mitrailleurs. It was pointed " out to me where the battery of mitrailleurs had been in action, and I " went there and found that evidently a battery had been in action, and " for a considerable period, because there was a great number of empty " mitrailleur boxes lying about. I noticed in the first place that the " position they had taken up was one that appeared to be splendid for " the use of the mitrailleur. It was just on the crest of very slightly " undulating ground in a perfectly open field: they had a sort of " glacis in front of them, extending down perhaps 800 or 900 yards " and a gentle hill opposite, extending for 600 or 700 more. The crest " of the opposite hill, the rise all being slight, was about 1,300 or " 1,400 yards off. It was at this distance that they had done great " execution." Subsequently he witnessed the employment of the mitrailleurs by the insurgents at Paris, who fired from the forts of Issy and Vanves at a range of 1,650 yards, with very little effect. Captain Brackenbury concurs generally with the other evidence that mitrailleurs are suited for purposes of defence, and although he does not consider that an army provided with these weapons, holds any very great advantage over its opponent who relies on field artillery, yet he believes them to be a valuable adjunct to that arm, and instances as a proof that the French Marshal commanding the 6th Corps regretted their absence from the right of the position at Gravelotte, and that the Prussian Officers looked on them with marked respect, and when called to face them, with decided aversion.

Mr. Charles Coffey witnessed the employment of mitrailleurs with great effect against a line of advancing Prussians at the action at Sillé le Guillaume, and coincides with the opinion of the French Artillery Officers with whom he spoke, that they were very valuable in war.

Major-General Walker, C.B., who was present with the German armies during the campaign, evidently agrees with the Prussian Staff in his opinion on the merits or rather demerits of the mitrailleurs. He sees no place for them in European warfare, as he believes them to be inferior to artillery, especially when good shrapnel shells are employed. He acknowledges their possible value against undisciplined troops badly provided with artillery, and in purely defensive positions, where the opponent is forced to advance on a fixed and narrow front, but deprecates any diminution in their favour of field artillery, and does not think that it is desirable to encumber infantry movements by attaching them to that branch of the service.

Colonel Hamley, R.A., who critically examined the evidence for and against the mitrailleur, condemns them absolutely for offensive operations, where, as must almost always be the case, the attack is to be preceded by a concentrated fire of artillery. Even for defensive purposes, in an open country, he considers that the effect, owing to their shorter range, would be less than that of artillery, but on the other hand, in certain positions where the area of attack is limited to 1,200 yards, and when the enemy is approaching on a narrow front, they might be most usefully employed.

On the German side, there is but one solitary instance of the employment of the revolving cannon, a description of mitrailleur, placed under the command of Captain Count Thürheim, and attached to the Bavarian corps of Von der Tann. The mechanism of these guns appears to have been defective, and Count Thürheim, after experience of their power, restricts their employment solely to defensive purposes in entrenched positions.

In giving this summary of the evidence taken by Colonel Wray's Committee, I must guard myself from the accusation of endeavouring to force conclusions by quoting only so much as would prove a case for or against the mitrailleur. I have endeavoured fairly to convey the impression produced by the several witnesses; but I would recommend all who are interested in the subject, carefully to study the evidence for themselves, as it is almost impossible by selecting particular passages, to convey a perfectly correct impression of the whole.

The deductions from its perusal appear to be as follows: 1. That the French Officers and those who have witnessed the campaign from the French side, are generally in favour of the employment of mitrailleurs in the field. 2. That the Prussian Staff disapprove of their introduction into the army, except for the very limited service of the defence of the ditches of fortresses. 3. That the English Officers, who were present with the German Armies, are with one exception of opinion that for certain purposes they may be useful adjuncts to field artillery. 4. Almost all who advocate their use, consider that they should form part of the artillery of an army, that they should supplement that arm, and that their place lies in defensive rather than in offensive tactics. 5. That their proper employment had not, possibly from want of opportunity, been carefully studied by French Officers previous to the war, and consequently that they were frequently unprofitably used. 6. That although the mitrailleur or Gatling (for both were employed by the French) of larger calibre was superior in range to the lighter arm, yet that owing to its increased weight, the horses necessary for its transport would nearly equal in number those of a field gun, and consequently that its advantages being more than counterbalanced by this drawback, a field gun would be preferred.

Second Report of Colonel Wray's Committee.

After duly weighing the evidence—of which I have endeavoured to give a summary—Colonel Wray's Committee drew up a second Report, on the 21st November, 1871, in which they laid down distinctly, that the mitrailleurs should be treated purely as defensive weapons, and that they should in general be entrenched and kept, as far as possible, masked from artillery fire. That the so-called small Gatling of ·45 calibre, of which the destructive effect against troops in the open at ranges up to 1,400 yards, is estimated as being nearly three times that of the 9-pounder field gun, should be so lightened as to be easily drawn with its carriage and ammunition by two horses, and, on emergency, by one. That the field artillery should not be reduced by a single man or horse for the sake of substituting mitrailleurs; but that these latter should be kept with the reserves of an Army in the field for the express purpose of increasing infantry fire at critical moments, in the same way that guns of position are used for strengthening the fire of field artillery. That the mitrailleur batteries should be provided with Nolan's range-finders.

With reference to the difference in opinion on these subjects between the German and French Officers, the Committee offer the following remarks, which I would recommend for your consideration:—"1. That "the Gatling gun was very little used by the French. 2. That the "French mitrailleur was almost as heavy, and required as many "men and horses as the field gun. 3. That the French appear, by "all accounts, to have used their mitrailleurs with little judgment, "firing them into all sorts of cover, at very long ranges, and without "any special means of ascertaining the distances. They seem also to "have frequently neglected the precaution of covering their mitrailleurs, either naturally or artificially, thus laying them open to destruction by the German artillery. 4. That the Germans had no "opportunity of testing the merits of mitrailleurs for defensive purposes, having almost invariably acted on the offensive. 5 (and I "would draw especial attention to this remark). That the Germans "have no necessity for considering the question of introducing these "weapons, being already well provided with a very large number of "French mitrailleurs, which, having recently been tried at Berlin in "comparison with Montigny and Gatling mitrailleurs, have been unanimously pronounced superior to either," an opinion, I would observe, in which the Committee did not agree. I would also add, that as during the war, the Germans were unprovided with an effective mitrailleur, and as the destructive effects of the fire of the French weapon had been bruited abroad with the object of elevating the *morale* of their own troops and depressing that of the enemy, it became almost necessary for the Prussian staff to decry its powers, and disabuse the minds of the soldiers of an exaggerated fear of its effects.

Most, if not all, the great Powers of Europe have provisionally adopted some description of mitrailleur. The French retain those they employed during the war. The Prussians possess large numbers, which were captured from the enemy. The Austrians are manufacturing machine guns, on Messrs. Paget and Broadwell's principle, and are attaching them to the regiments of Hungarian militia. The Russians are making large numbers of Gatlings, on (I believe) Colonel Gorloff's principle, and it is said that 400 or 500 guns are ready, or are nearly completed. The rapidity of fire is stated to have been increased up to the almost incredible number of 1,000 shots per minute, which rapidity can, however, be regulated and checked by a simple adjustment of the feeding apparatus. The gun has been lightened, and the spreading motion of its fire improved. The Turks have ordered a large supply similar in pattern to that selected by Austria. With regard to America, although it appears that there has been no formal adoption of the mitrailleur, their utility has been reported favourably on by

American Officers, and the manufactory with which Mr. Gatling is connected, has every means of turning them out rapidly in the event of war. They are employed in arming the forts in the Far West against the attack of Indians; and (as I have been to-day informed by Captain Selwyn, R.N.) a certain number are in readiness at Salt Lake City, in the event of any trouble with the Mormons.

At present no Government has given orders respecting their tactical employment, and it is on this point that I would venture to direct your opinion, trusting that a discussion by able Officers of all branches of the two services, may tend to elucidate a question which at present presents many complications, and is attended with considerable difficulty.

Comparisons in the Equipment of 9-pounder Field Gun and Gatling Batteries.

In order to assist in forming conclusions, I am enabled to offer an estimate, prepared by Colonel Wray, of the comparative number of horses, men, and waggons, which are required for a battery of six 9-pounder field guns, and for a battery of twelve Gatlings.

Comparative Equipment of a 9-pounder Field Battery of 6 guns, and of a Battery of 12 Gatling Guns.

9-Pounder Field Battery. 6 *Guns.*	*Gatling Battery.* 12 *Guns,* ·45 *calibre.*
1 Captain.	1 Captain.
1 Second Captain.	1 Second Captain.
3 Lieutenants.	3 Lieutenants.
1 Assistant-surgeon.	1 Assistant-surgeon.
6	6
1 Serjeant-major.	1 Serjeant-major.
1 Quartermaster-serjeant.	1 Quartermaster-serjeant.
6 Serjeants.	6 Serjeants.
6 Corporals.	6 Corporals.
6 Bombardiers.	60 Gunners.
85 Gunners.	
81 Drivers.	20 Drivers.
2 Trumpeters.	2 Trumpeters.
1 Farrier.	1 Farrier.
4 Shoeing smiths.	2 Shoeing smiths.
2 Collar makers.	1 Collar maker.
2 Wheelers.	1 Wheeler.
197	101

6 Guns.
12 Waggons.
1 Store waggon.
1 Forge waggon.
1 General Service waggon.
1 Store cart.
214 Rounds per gun.

Riding Horses.

12 Officers'.
2 Staff Serjeants'.
12 Non-commissioned Officers'.
2 Trumpeters'.
1 Farrier's.
1 Shoeing smith's.
4 Spare.
—
34

Draught Horses.

48 Guns.
72 Ammunition waggons.
6 Store waggon.
6 Forge.
4 General Service.
2 Store cart.
12 Spare.
—
150
—
184 Total horses

12 Gatling guns.
6 Small arm ammunition carts.
1 Store waggon.
1 Forge and General Service waggon combined.

2,208 Cartridges carried with each gun 26,496
9,000 Cartridges in each S.A.A. cart 54,000
12)80,496
Cartridges per gun 6,708

Riding Horses.

12 Officers'.
2 Staff-serjeants'.
12 Non-commissioned Officers'.
2 Trumpeters'.
1 Farrier's.
1 Shoeing smith's.
4 Spare.
—
34

Draught Horses.

24 Guns.
12 Small arm ammunition cart.
6 Store waggon.
6 Forge and General Service waggon combined.

8 Spare.
—
56
—
90 Total horses.

The total weight of draught of the Gatling is as follows :—

	cwts.	qrs.	lbs.
Gun carriage when complete	7	0	7½
Limber ditto	5	0	25
Six drums filled	3	2	0
Total...........................	15	3	4½

Supposing a shield to be introduced for protection against the fire of infantry, an advantage which I scarcely think counterbalances the additional incumbrance, 3 qrs. 25 lbs. would require to be added to this weight, making a total of 16 cwt. 3 qrs. 1½ lbs.

There is another important question bearing on this portion of the subject which should be considered, especially as the opponents of the Gatling gun found their chief objection to its supplementing artillery, on the increased "impedimenta" thereby arising on the line of march. That a battery of twelve Gatlings must cover a considerable length of road is of course a fact that cannot be controverted, but comparing the space occupied with that covered by a battery of six 9-pounders, the advantage will tell considerably in favour of the Gatling, as is shown by the following table, also prepared by Colonel Wray :—

Space occupied by a battery of six 9-pounder field guns, as compared with that occupied by a battery of 12 Gatlings :—

9-Pounder Battery.

	Length in yards.	Total.
6 guns, 8 horses	19	114
12 waggons, 6 horses	15	180
1 store waggon, 6 horses	15	15
1 forge, 6 horses	15	15
1 General Service waggon, 4 horses	11	11
1 store cart, 2 horses	8	8
Total in yards		353

Battery of 12 Gatlings.

	Yards.	Total.
12 guns, 2 horses	7	84
6 carts, 2 horses	7	42
1 store waggon, 6 horses	15	15
1 General Service waggon and forge combined, 6 horses	15	15
Total in yards		156

Should it be required to divide the battery, either on the march, or when about to come into action, the two captains would each take a half battery of 6 guns, or if subdivided, the three subalterns would command divisions of 4 guns, in place of 2, as in a field battery.

If you accept these calculations as correct, you will, doubtless, in the comparison between the Gatling and field artillery, give due weight to the comparatively small number of men and horses required for the former, as opposed to those necessary for the service of a battery of field artillery, and will balance these advantages against the greater power and range of the field guns. There can, also, be little doubt but that Gatlings will, from their lightness, be able to move over ground impassible for artillery, and that, although their range may be less, their effect at distances under 1,200 yards will certainly be found to be more deadly.

In the Duke of Wurtemberg's pamphlet, it is stated that the Prussian artillery usually open fire at distances varying from 1,400 to 1,600 paces, whilst Colonel Reilly corroborates this statement in his evidence given before Colonel Wray's Committee, by saying that at an action at which he was present near Orleans, their horse artillery fired at 1,200 yards, or within the effective range of the small Gatling.

The traversing arrangement for spreading the shots during the time of firing, adapted to the Gatling gun, removes the objection raised against the French mitrailleur, that they carried so close as to put several bullets into the same men; whilst the absence of recoil, enables the fire to be steady as well as continuous, the rapidity being regulated at the discretion of the firer.

The questions before this meeting are, first, whether the mitrailleur or Gatling is adapted for modern warfare under any circumstances. If so much be conceded, it remains to be settled whether it should be attached to infantry, or cavalry, or should form part of the artillery of an army.

On this point the balance of the evidence examined before the Committee inclined, with one exception, to making Gatlings a supplementary part of the artillery force. Not that they should be attached to artillery batteries, but that they should be treated tactically in a manner similar to that arm of the service. Great independence has, by a recent regulation, been given to Officers commanding batteries of field artillery. They are now required to support the operations of the other branches of the service, without hampering their action by conforming too precisely to their movements. So with Gatlings. Officers in command of "Gatling batteries" will require an especial tactical training, and will have to learn their proper employment in the field. If for purposes of organisation these batteries should be composed of twelve guns, it should be clearly understood that their division and subdivision for tactical employment would not only be probable, but would be almost certain, as I can conceive no situation where any large number of Gatlings could with profit be employed together. Their province would usually be to remain concealed behind some hastily raised breastwork, until the opportunity should arise of pouring forth their stream of deadly fire. To show themselves to artillery at the longer ranges in open country would be to court destruction; but to profit by their comparative insignificant size, and to bide their time until the enemy's infantry should advance, seems to be the *rôle* laid out for them in field operations. Now and then they might be called to the front, especially in enclosed country, but *defensive* rather than *offensive* tactics appear best suited for the full development of their powers.

As has been already stated, the Hungarian Government is reported to be in favour of attaching mitrailleurs to regiments of Militia, hoping by this means to give moral and material support to raw troops. To this opinion I would venture to dissent, on the following grounds:—Infantry ought, under the present conditions of warfare, to be rapid in movement. Preceded by clouds of skirmishers, and pressing onwards in successive waves, they must, when once engaged, sweep forward, availing themselves of all undulations of the ground for shelter from the enemy's fire. To wait for Gatlings, to rely upon them for support during their advance, or for cover when repulsed, would be to lose their elasticity, and would tend to lead men to depend upon extraneous help, rather than on their own rifles and bayonets. The very ground that infantry would select for action would be unsuitable for wheeled transport. Regimental Gatlings would either hamper the action of the troops to which they might be attached, or would be left uselessly in rear, vainly endeavouring to follow, and seeking fruitlessly for opportunities for coming into action. The reason against attaching field-guns to infantry would apply, only in a lesser degree, to uniting Gatlings with infantry. The action of artillery and of Gatling batteries should be separate from that of the infantry; each has its proper duty to perform, but these duties are distinct, and should consequently be kept separate.

None of the evidence was in favour of using Gatling batteries in place of horse artillery. The inferiority of their range to that of field-guns would probably lead to their destruction if opposed to horse artillery on open ground suitable for cavalry operations. It is, however, fair to say that no practical experience has elucidated this question, and that some Officers hold contrary opinions to that which I have ventured to suggest. That they will be found most useful for flank defence of ditches, for sweeping the approaches in front of field-works, for playing on the head of a sap, and for employment in the trenches and approaches of a besieging force, Engineer Officers will, I think, allow; their lightness, handiness of movement, the absence of recoil, and the continuity of their fire, seem peculiarly to fit them for such uses. The necessity for, and yet the difficulty of, bringing field guns into the advanced trenches to check sorties was felt during the siege of Sebastopol. The greater mobility of the Gatling, and its acknowledged superiority in deadliness of fire at short ranges to the 9-pounder field-gun, point to its employment in future sieges. How best to entrench it, is also a question to be decided by Engineer Officers. To restrict its action within the limits of an embrasure would be unduly to diminish its powers, and prevent the development of the sweeping fire caused by the lateral movement of the barrels as they successively discharge their shots. For the defence of defiles and of bridges Gatlings are well suited, although, on the other hand, for attack against entrenchments or barricades they appear to be almost valueless. For naval purposes such as have already been indicated, the Officers whom I have had the privilege of consulting, agree that they will be found very valuable, and to this opinion I have as yet heard no dissent.

In a paper written by Captain Rogers, which appeared in the January number of "Once a Week," it was suggested that Gatlings might be usefully employed in some of our colonies, when small numbers of Europeans may be engaged against savage tribes. They are easier to work than artillery, and consequently would be better adapted for comparatively untrained men, such as colonial Volunteers must, from the circumstances which surround them, frequently be. They are also readily moved through districts when the roads would scarcely admit of the passage of field-guns.

To all these points, and doubtless to others which have escaped my observation, I would direct your attention, and trusting that the evidence I have been able to collect may prove of use in enabling you to form conclusions on the important question involved in the employment or rejection of this description of weapon, I leave the matter in your hands, availing myself of this opportunity of thanking Colonel Wray, Captain Beaumont, the officers of this Institution, and others, for the information they have afforded me on several technical matters relating to the subject.

The Mechanism of the Gun.—On the mechanical construction of the gun I have purposely refrained from touching, the subject of the lecture being the employment of the mitrailleur in war. A description of its several parts will be found in Mr. Gatling's paper, published in the Journal of the Institution, vol. xiv, whilst the gun itself is present for inspection.

On two points only do I wish to make remarks. A feeding apparatus consisting of a drum containing 336 cartridges has replaced the hopper previously used. Thus the rapidity of fire has been greatly increased, and the risk of the jamming of the cartridges removed. The diameter of the bore also has been made similar to that of the new Army rifle, the Martini-Henry. The ammunition is not, I regret to say, interchangeable, as the bottle-necked form of the Martini-Henry cartridge is unsuited to the mechanical method of loading the Gatling, from its not passing smoothly down the drum into the chamber. Possibly this defect, not in the gun or its cartridge, but in the uniformity of the armament of the Gatlings and of the infantry, may be remedied; but even if the former require a separate ammunition, I do not conceive that inconvenience in storage or in issue will be found to arise.

In conclusion I have only one observation to offer. History shows with no doubtful indications, that it is not merely to the improvement of arms that nations have owed their successes in war. To take the most recent instance. The French infantry were incomparably better armed than their opponents. They were taught to rely on their chassepôts and on their mitrailleurs, but they were not sufficiently instructed in the method of employing them. They were wanting in the steadiness and discipline which rapidly-firing arms require, and as their confidence in the new weapons had been unduly exalted, so when results failed to fulfil their anticipations, their *morale* became impaired. By all means furnish soldiers with the best arms that can be procured, but at the same teach them, that battles are not won by arms alone, but by that combination of courage, discipline, and skill, which pertains to vigorous nations, and to well-trained troops.

Captain Rogers: As Colonel Fletcher has kindly alluded to me, I will offer a few remarks; and first of all, I may express the hope that an audience such as the present one will often meet within these walls to discuss, and listen to discussions, on subjects of such vast and paramount importance to the nation at large. There is one Gatling gun that Colonel Fletcher has not alluded to, one of small bore, 0·45; but I hardly think that it has yet been sent to England.* It also has ten barrels, but it weighs only 125 lbs. It is designed to be carried on the back of mules, camels, or elephants, or it can be mounted on a tripod (which enables it to sweep an entire circle), and be fired at the rate of 300 rounds per minute. Just consider what an admirable protection this would be for a small detachment at bay. Take, for instance, that small but unfortunate band of Jamaica volunteers, who, back to back, fought and fell around the Morant-Bay Court-house; how differently they would have fared if they had been in possession of such a gun. And throughout the mutiny in India, what an admirable auxiliary to self-protection in isolated positions, would have been this ingenious man-slayer. But apart from its deadly effects, there would be with the Gatling, under certain circumstances, an awe-inspiring moral effect, inestimable, except to men who have been placed in positions to understand the import of an unknown power, or to note its effects upon untutored minds. In this respect I may quote or parody ÆNEAS:—

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* This gun is now under trial.—Ed.

> "Quæque ipse misserrima vidi,
> Et quorum pars '*parva*' fui."

In 1867 we had a "little war" in British Honduras, and on one occasion during it I witnessed the effects of rockets on Indians, effects which would have been ludicrous had they not been so serious. Scarcely had two or three rounds been sent over a village, than the enemy in utter consternation took to flight, betaking themselves with frightful yells into the surrounding bush. Now such a Gatling as I have described would, no doubt, have produced the same amount of abject terror: but how many also would it not have placed *hors de combat!* The rockets, however, did their work of frightening only too well, for these eccentric missiles went harmlessly over the heads of the Indians who "lived to fight another day." Most of our future wars will be on a comparatively small scale. We cannot, if we would, muster the big battalions that marched majestically over the desolated plains of France. Consequently our future fighting operations will be more or less connected with those "who go down to the sea in ships and have their occupation on the great waters;" and in such hastily organised expeditions as *distance* will impose upon us, can any gun be more admirably adapted to the work than the Gatling? But in all English colonies the monopoly of possession should be secured to the Government for this reason, that hitherto, in a spirit of freedom, we have allowed our merchants to supply ammunition and material of war to the very factions or rebels whom we are called upon from time to time to fight. I have myself witnessed the effects of this disastrous policy on the West Coast of Africa, where the very merchants, who urged on "war to the knife" in protection of their homes and property in their mercantile capacity, were furnishing the enemy with the means of destruction. This should be looked to. I will merely add, that in future wars of this character, if the Government should send out Gatlings to colonial stations, local ordinances should be enacted to prevent the importation of such guns by the natives.

Captain H. BRACKENBURY, R.A.: Col. Fletcher has quoted evidence of mine as to what I saw after the battle of Sedan. I very much regret that when I was summoned before the Committee, I had not then had the opportunity which I subsequently had of visiting and studying with great care all the battle-fields of the war in which the original French Army fought. I have since, in going over those fields, seen more than one place where the effect of the mitrailleuse had been most deadly. There is that wonderful instance of the ravine close to the *Bois des Ognons*, at Rezonville. Now we have very plain evidence as to whether the French considered the mitrailleuses to be more effective than guns in certain positions, by this fact, that Marshal Bazaine, who was there on the spot himself, had plenty of guns under his hand, but had only two batteries of mitrailleuses: and to defend the head of that ravine (this was after having seen previous battles), he brought up his mitrailleuses. Anyone who has seen that battle-field, who has seen the way in which the graves are at this point piled almost one upon another, will see how awful the slaughter must have been, and it was due, practically, entirely, to these mitrailleuses. There is another peculiar case, and that is on the western side of the battle-field of Sedan. On the heights, close to Floing, there was placed a battery of mitrailleuses. There is opposite to that a round hill with wood on the top, and out of this wood and from behind this hill came the Prussian columns; as they came out they were swept down by these mitrailleuses, and they did not succeed; they could not make any progress, they were obliged to go back again and go round on the reverse slope of the hill, checked by the mitrailleuses. There is another example I might give where the mitrailleuse did remarkable work, that is in defence of the railway bridge at Bazeilles. The Bavarian columns came down and endeavoured to cross that railway bridge, of course, preceded by their skirmishers. Two mitrailleuses only, I believe, were placed behind a garden wall, and they simply swept that bridge, so that the Bavarians could not pass it. These are instances of what the mitrailleuse can do. Now, I have lately been passing the Christmas and the new year with Marshal Canrobert, who commanded the sixth corps on the right of the French position at the battle-field of Gravelotte. I have had the advantage of talking not only to his staff, but also to some of the staff of General Ladmirault, who commanded the Fourth corps. I hear from the Sixth corps one universal expression of regret that they had no mitrailleuses. "If we had mitrailleuses to place behind those walls at St. Privat and those farm "buildings of Jerusalem on the road, not only would the Prussian Guard have been "repulsed as they were more than once by our infantry, but when our infantry had "become demoralised by their crushing artillery fire, had mitrailleuses been placed "behind those walls it would have prevented their coming up again." I noticed this also on this battle-field of St. Privat. The Guard attacked in two bodies, on the right of the road and on the left of the road. On the right of the road as they came up there were the mitrailleuses of Ladmirault's corps, on the left of the road there were no mitrailleuses in Canrobert's corps. The columns on the right of the road suffered much more than the columns on the left of the road; I do not say entirely owing to the mitrailleuses, but I give you that as a fact. These are instances in which the mitrailleuse has been very formidable. Certainly those French artillery Officers whom I have asked about it, are strongly in favour of retaining the mitrailleuse in their army; but they all agree in saying that their artillerymen must be taught better how to use them. There is no question whatever that they fired away their cartridges at 1,500 and 2,000 yards against the enemy's troops almost as soon as they came in sight, and the result was that when the enemy came up to the mitrailleuses in position they had sometimes no cartridges to fire. It was the same to a certain extent, with the chassepôt.

There are positions in which the mitrailleuses are invaluable, but I must say if we are to introduce them into our service I want to see a lighter carriage than the one before us. I want to see a carriage with less width between the wheels and of a lighter construction; I want to see a carriage that can be run into a building; knock down a bit of the wall, run the mitrailleuse into the building, knock a hole through the wall, and on the enemy's side put the muzzle through the hole. You cannot make a wall full of loopholes; if you do it scarcely offers any resistance, and infantry do not like standing behind it; but place a mitrailleuse at a loophole and what a tremendous effect will be produced! And mark how much on the battle-field depends upon holding certain positions, such as villages and farm buildings. I believe that behind the walls of such buildings the mitrailleuse will be invaluable; but as to using the mitrailleuse in the attack, it is clearly evident that that is impossible. What is the principle of attack now? What do we see in all those battle-fields but one single plan of attack? First the infantry is utterly demoralised by the crushing fire of a mass of artillery concentrated upon it, then masses of skirmishers or columns are sent up to attack. What can you do with the mitrailleuses? they are of no use in the attack; but in the defence, I believe in certain positions, they are invaluable, and I hope that we shall see them introduced into our army, but not hampering infantry by being rigidly attached to them. I must object to batteries of twelve guns. I never saw a position (except in the open, where of course they are liable to be crushed by the long-range artillery fire of the enemy) where you could place a battery of twelve mitrailleuses, and when you get behind a building you could never get twelve mitrailleuses together. Why attempt an impossibility like that? Why not be content with a battery of three or four mitrailleuses?

General ADYE, C.B., R.A.: Having had occasion for some time past to study this question, I am anxious to address a few words to the present meeting. I quite agree with what has been said as to its importance, and consider it a very proper subject to be discussed in this Institution; and we may congratulate ourselves on the impartial and excellent manner in which Colonel Fletcher has brought it before us. The subject of mitrailleuse is not a new one, as Colonel Fletcher has pointed out to us; but hitherto it has had little success. Within the last few years, however, the subject has revived. We became acquainted with the fact that the Prussians had made careful experiments, and had rejected mitrailleurs, and that the French had taken the opposite view, had adopted them largely and prepared many batteries which they produced in the field in the recent war. We on our part understood that the Montigny mitrailleur and the Gatling had been much improved in their mechanism, and were stated to be also improved in their power. Therefore, we made careful experiments, and the result was that we have, to a certain extent, adopted the gun which is before you. Now, in considering the uses of the mitrailleur with an army, we must remember that in its general attributes it is a field gun; that is to say, mounted on a wheel carriage, it requires horses for its draught, men to man it, and waggons for its ammunition. Therefore, it has the *impedimenta,* in proportion to its weight, and the exposure, of field artillery. When we examine the experiments that have been made, we find that it has one advantage, namely, that within the limits of musketry range, it can pour more bullets into columns of troops advancing in the open than a field gun. That is a great advantage, but it is its only one. We must remember, that a field gun has a great incendiary power; it can set fire to villages, destroy walls, stockades, and entrenchments; it can smash and overturn the enemy's artillery, their ammunition waggons, and their baggage; while in all these respects the mitrailleuse is powerless. So that whilst the mitrailleur intensifies the power of artillery in one respect within limited ranges, it does so at the sacrifice of all those qualities which make field artillery so formidable. It does one thing well, and the rest not at all. Now, that to my mind is a very important matter. We are told again that the mitrailleur is of no use for attack, but only for defence. And we are told that the French did not display its qualities well; that, however, is rather a peculiar argument to use, because the French were on the defensive the whole time, and, therefore, one would have thought that if it has peculiar qualities for defence they would have come out in the French war. Up to the present moment I have been speaking of the mitrailleur as compared to the field gun within the limits of musketry range. We must, however, remember, that beyond those limits, the field-gun goes on increasing its effects up to two or three thousand yards; and all that time the mitrailleur is silent. This is another important question to consider. Infantry troops supported by mitrailleurs might, I think, be disheartened, if they found that they were played upon by the enemy's artillery, whilst their own mitrailleurs could make no reply. I had the advantage of speaking to a distinguished Prussian General Officer some short time ago, and what he told me was this, that when (during the last war) they discovered the position of the French mitrailleurs in action, they played upon them with artillery at long range, and snuffed them out; they drove them off the field; for the very reason that I have attempted to explain, that the mitrailleur was incapable of reply. I have a great regard for the military opinion of the French, but in my opinion (formed before the war) they committed an error in their hasty adoption of mitrailleurs. They did so with a certain amount of mystery and secrecy which for the moment, perhaps, enhanced their value, but which in the end achieved no object. Those who argue in favour of the mitrailleur, will tell you, that they do not contemplate the reduction of a single gun, but would take them in addition to a full proportion of field artillery. But here another difficulty meets us. What are the rules which determine the proportion of guns in the field? What is it that limits their number with an army? Why do we lay down a rule that about three guns per thousand men at the most can be advantageously employed? Because when the *impedimenta* of artillery reach a certain point, we find that artillery, instead of being an advantage and a support to an army, tend to hamper and embarrass it. As an artillery Officer, it is not likely that I should depreciate or ignore the great power of the arm; but I acknowledge, and all artillerymen acknowledge, that there are limits in these matters. If you will allow me, I will read to you the opinions of another artilleryman, an Officer who is a great authority, Colonel Hamley. In his "Operations of War," speaking of the campaign of 1859 of the Austrians, he says:—"The reader will have noted that both at " Austerlitz and at Solferino, the beaten armies brought to the field a great preponderance of artillery, a large part of which took no part in the engagement. The " truth is, that the huge trains which followed their columns were too unwieldy to " be arrayed. Surplus artillery is far worse than useless; it hampers and delays the " columns, destroys roads, perplexes Generals, keeps troops out of action for its " escort and protection, and impedes the retreat. The proportion of guns to men " at Solferino, namely 2⅗ to 1,000, is probably as large as can exist with advantage " in great armies. This is more than ever true, since the increased mobility of artillery, and the widened sweep of its horizon, have augmented its effect compared "with its numbers." Therefore, those who argue that you should take the full proportion of artillery, not diminishing a gun or a man, and still take the mitrailleurs in addition, have to explain how they will overcome this difficulty. I am informed that a distinguished General Officer, Prince Frederick Charles, says:—"If you are "able to take more wheels, more *impedimenta*, more weapons into the field of that "kind, then give me more artillery." That is, he would prefer additional field guns rather than mitrailleurs. It is also stated that the mitrailleurs may be useful against boat attacks. Well, it appears to me to be a question whether a gun which will fire a shot to cut a boat in half and sink it, may not be a more effective weapon even in that respect than pelting them with a shower of bullets. I have not alluded to the expense, nor have I alluded to the comparative delicacy of the weapon. Its expense is very considerable; I believe it is about £220 or £230 compared with £90, the cost of a 9-pounder field gun. That is, however, not a material point, if the great principle is established, that mitrailleurs are useful in the field; its delicacy also might perhaps be overcome. Therefore, what we have to consider is, the probable use of mitrailleurs in the wars of the future? It is important to my mind that public opinion should be formed upon this point. I do not think it is formed yet. And it is very important also—it is essential—that military men should take the lead in forming this opinion; that we must exercise great care and caution before we allow ourselves to be run away with by comparatively untried novelties. We must deliberately see whether by adding mitrailleurs to the Army, we shall increase our powers. Possibly for certain limited fixed positions for defence these weapons may be useful. But, as far as my experience goes, it is this, that we require in modern battles long-ranging, hard-hitting weapons, such as I believe we possess in the present rifled muzzle-loading 9-pounders and 16-pounders. Therefore, it is to me a great question, whether we shall do wisely in taking mitrailleurs into the field. I have thought considerably about the matter for some time, and believe that the uses of mitrailleurs must always be of a limited and exceptional character.

Captain BEAMISH, R.N.: I did not come here with the intention of making any observations upon the question before us, because I had not had the opportunities which I should have liked to have had, of learning all about the weapon. Further than that, I have read little about it. But during the course of the evening I have heard all that has been said, and having paid attention to it, I would ask your permission to make one or two observations as to the part that I think the Gatling gun (not necessarily so large a gun as that) might take in naval matters. First, I am disposed to think that I should not like to see it substituted for guns in boats altogether, only partially. In all matters of naval attack where boats are used, it is absolutely necessary to cover the attack that is made by the boats. It occurs occasionally, but really not very often, that the ships from which the boats are detached can cover the landing; but very generally it does not so occur, and the boats themselves have to cover their own attack. I have had at times formerly, a little experience of something of the sort, and I have suffered greatly, or rather seen a great deal of suffering from the effects of not being able to cover our own attack, partly because of the recoil of the guns in the boats. This is not likely to be the case, as I understand, with the Gatling gun; and more than that, instead of being worked by four or six men, it can be worked by two. Therefore, not requiring more than two men to work it, the gun can be worked all the time that you are pulling towards the landing place to cover your landing. I think if well-trained men had to use it, they would work the machinery without any great distraction, and without any great mistakes. As I said before, it might not be necessarily substituted for guns in boats, such as the guns we usually carry, which are the Armstrong breech-loading guns; but I think there might be put, perhaps, one into each ship, and certainly one into each of our large ten- or twelve-oared cutters, which could easily carry them, and which now can carry no gun. With regard to an observation made by General Adye about the Gatling not being valuable against the landing of boats, I, on the contrary, think it would be extremely valuable, for its range is large, and it is not at all an easy thing to hit a boat with a round shot; but it is an extremely easy thing, when firing at a straight pulling, narrow object like a boat, to cover it with a Gatling. Moreover, it is extremely valuable in a boat to keep down the fire of any Gatling that may be on shore. It strikes me that it has got another advantage about it, which is particularly valuable. The projectiles that we have for boats are shell, round shot, and shrapnel. We do not fire case out of an Armstrong. Ordinarily, you are obliged to cut the fuses. It is, too, a most awkward thing to keep your ammunition in the stern of your boat; certainly, your fuses are always cut there. There is a great deal of confusion in cutting fuses, when every moment of your progress you are constantly altering your range, so that, however many fuses you cut beforehand, you hardly ever have fuses so accurately cut that they can do the work that a Gatling could do, for you can constantly work the latter all the way to the landing. I think that is a great advantage. I think there would be great advantages in the use of the gun if we could put a small one into every large boat which carries a gun, and into every cutter that does not carry a gun. If you could get a light Gatling, such as was mentioned by Captain Rogers, or a gun between the one I see before me and the one he mentioned, a small boat could carry it, and it would be a very effective weapon. Lastly, on board ship they would be very valuable in the tops round which screens are always placed now-a-days; they would add greatly to the efficiency of rifle fire, and keep down that of the enemy. And if we are to have men-of-war rammed, there is no doubt that the crew of the vessel that rams another will make a struggle to get on board the other; and in that case a well-placed Gatling, well aft or well forward, could keep the side of the deck on which the enemy came on board positively clear, some of their own men being on the other side, and some of them in the rear.

Colonel **Wray**, C.B., R.A: I should like to explain a remark made by Captain Brackenbury with reference to the organisation of the battery of twelve guns, for which I am responsible. They are placed in batteries of twelve simply for the sake of organisation. You can see by the number of officers employed that a battery can be broken up into any number of parts. It was never intended that they should be taken into the field as a battery of twelve, or used as a battery of twelve. I think you can hardly look at those tables and study them carefully, without being satisfied that there are some good qualities about the Gatling. For instance, if you take the space covered by a battery of twelve, you find that it takes up about half the space of a 9-pounder battery of six guns. Then again it takes only half the number of men and horses. Again, it delivers, in comparison with the weight of ammunition carried, three times the destructive effect up to 1,200 yards, and, I believe, up to 1,600 yards, though as yet it has not been tried up to that range. Therefore with a battery of twelve Gatlings you can get the effect of thirty-six guns, or six field batteries up to 1,200 yards for resisting attacks. The Committee never proposed that they should be used for attack, but simply in defence. It unfortunately happened at Shoeburyness, when H.R.H. the Duke of Cambridge came down to see the "Gatling" fired, the gun was not sighted, and the practice was most indifferent; in fact, the result was such that the whole of the Committee were strongly opposed to the Gatling as strongly as anybody could be. After trying it for six weeks,—and we took a great deal of trouble,—the Committee came to the conclusion that there was some good in the weapon. And I believe a good many people who are now against the gun, will by this time next year be of the opposite opinion.

Colonel **Fletcher**: There are very few remarks requiring answers from me, because many of the objections that have been raised against the Gatling have been answered by Officers present in a much more effective manner than I can do. I was very glad that Colonel Wray explained to Captain Brackenbury that the organization of the Gatlings in batteries of twelve guns was simply as a means for organization and not for tactical purposes. Because I agree with Captain Brackenbury, that it would be impossible to find any position where batteries of twelve guns could be employed. I look upon two or three guns as the largest number that could be brought together in any particular place for purposes of defence. One remark made by General Adye I should like to say something about. He drew attention to what had passed between a distinguished Prussian Officer and himself with reference to the manner in which the Gatlings were knocked over by the Prussian artillery whenever they showed themselves on the field. When Colonel Reilly was present at one of the battles before Orleans, he distinctly saw batteries of mitrailleurs in the open, employed for a considerable time within 1,200 yards of the Prussian horse artillery, and the horse artillery did not touch them during the whole of that time.

In reference to the comparison between Gatlings and artillery, I think there are elements of error in artillery fire which, to a certain degree, are greater than those in the Gatling. I quite agree that with the Gatling there is a difficulty in ascertaining the range; there is not the opportunity of seeing where the shots strike as when a shell is fired from artillery. On the other hand, there is not the element of error inseparable from the employment of fuses. Any person who has watched artillery fire, must have been struck with the error consequent on faults in the fuses; either they do not act properly, or they burn too quickly, or too slowly. I am speaking of time-fuses. Consequently it is, I think, fair to the Gatling to give it so much advantage in its comparison with artillery. Then with regard to the expense of the Gatling as compared with that of the field gun, although the Gatling itself may be more expensive in manufacture than the field gun, yet, if you compare the two together, and take into consideration the greater expense of horsing and manning the field gun, I think you will find the cost of the Gatling is considerably less. I was rather struck with a remark of Captain Brackenbury with regard to lightening the carriage. It is a subject upon which I feel I am not competent to give an opinion; but, if it be possible to lighten the carriage and make it smaller, there can be no doubt a great improvement would be effected. I am also glad to hear what Captain Beamish said with reference to the adoption of Gatlings for boat operations. The opinion of a naval Officer on this subject is of great value, because the question has not been much discussed by naval Officers, and we have not, therefore, had the advantage of hearing their opinions. In conclusion, I would remark that the great question is, whether the advantages of the Gatling counterbalance the increased *impedimenta* which it must necessarily entail in warfare. The *impedimenta* entailed by a battery of Gatlings has been shown by Colonel Wray's table, which gives the length in yards occupied by twelve Gatlings as compared with six 9-pounders, to be considerably less than the *impedimenta* of field artillery. But if you add Gatlings to your field artillery you increase your *impedimenta* in the same way that if you add ammunition carts to infantry consequent on the increased number of rounds now necessary, you increase the *impedimenta.* The whole question is one of degree. If you wish to have an arm between artillery and infantry, you must make up your mind to have the increased *impedimenta* which that arm will entail. I think the real point which both artillery and naval Officers ought to consider, is the right employment of the Gatlings, and how and in what positions the full development of the deadly fire, which no doubt they possess, can best be attained.

The CHAIRMAN: Before asking you to accord, as you will heartily do, your thanks to Colonel Fletcher for his able and unprejudiced statement of the subject, I may be allowed to make a few remarks. It appears to be generally agreed by the meeting that this weapon is certainly available for, and is likely to be a very valuable aid in, defence. As regards attack we should not decide hastily against it, as experience shows that many modifications of existings modes in war are necessarily taking place. Nor can it be said that the proportion of artillery to infantry is so rigidly fixed as not to admit of relaxation, as regards the *impedimenta* of that branch, if experience shows its necessity. If the system is to be looked upon as one for defence *only,* it is likely that there will soon arise some difficulty in its application, as it will come to be considered as a mere reserve, and will seldom be found ready at the critical moment when it is most needed. All, however, appear to be agreed that as regards specific positions, defence of bridges, and such like, it is an important arm.

Colonel Fletcher has put the question fairly when he asks, "Is the advantage commensurate with the additional expense and trouble and the addition to the *impedimenta* of an army?" At present the answer to this question is left among very divided opinions.

As regards the weapon itself, though it has only become possible with the increased mechanical skill of the day, I confess that I am not at all satisfied with the arrangement by which the drum for holding the cartridges is placed in so exposed a position. It seems more than probable that a single ordinary rifle bullet striking the drum, even if it did not explode the whole of the contents, would so far injure thearrangement as to render it temporarily useless.*

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* It will be seen, on referring to the plate, that the drum is now protected from fire.—ED.

I will now convey to Colonel Fletcher the thanks of the meeting for his paper, which bears such evident marks of the ability which he has brought to bear on the service of the Committee of which he is so active a member.

MEMORANDUM BY MAJOR-GENERAL CAMERON SHUTE, C.B., late Commanding 4th Dragoon Guards.

Lieut.-Colonel Fletcher's interesting paper tends strongly to prove that mitrailleurs are likely to be employed in future wars.

The three questions, then, arising, from his observations, which I would very shortly argue, are the following, viz. :—

1st. Should mitrailleurs be attached to each infantry battalion as part of its establishment?

2nd. Should they be similarly attached to each cavalry regiment?

3rdly. Should they be formed and equipped in batteries of eight or twelve guns and form a portion of the Artillery Service?

First, then, as regards infantry. If mitrailleurs—say two guns—formed part of the regulated establishment of a battalion, this must entail the necessity for well-instructed farriers, wheelers, saddlers, non-commissioned Officers, and men who can ride and understand the care of horses, besides a considerable reserve of others qualified to fill up casualties, as well as spare horses, to replace the sick, lame, killed or wounded; and a special commissariat establishment.

We must, then, next consider how far the value of these guns, for the usual exigencies of the infantry service, would justify a battery of them, constituting, so to say, an integral part of a battalion.

Doubtless they would occasionally prove very effective on "outpost duty," particularly where a piquet has orders to hold the ground entrusted to it, perhaps a gorge, defile, or important cross-road, and to defend it to the last; also in the defence of bridges, or in retreating through streets, or by roads and lanes, though in the latter cases, great care must be taken to prevent an enemy from taking them in flank by detaching skirmishers across the country on either side.

In but few other instances would these guns be of more value than the rifles of the battalion to which they were attached. For to open an attack for infantry, it is generally desirable that the supporting guns should be capable of acting with effect against troops covered by shelter-trenches, woods, buildings, fences, banks, walls, &c.

Again, with infantry acting on the defensive,—if the position be judiciously selected,—their well-protected artillery should have free scope for their full length of range, so that the attacking enemy should of necessity be exposed to the devastating and demoralising effect of their fire over from 2,000 to 3,000 yards of their advance, and to which even their supports and reserves should gradually become exposed.

If, then, I am correct in believing that in neither of the latter instances would mitrailleurs give the desired support, I am decidedly of opinion, that we should not be justified in adding a battery of them to each battalion, requiring as it would, a complicated and expensive establishment, foreign to the arm, and which the commanding Officer, unaccustomed to the many details of mounted troops, would but ill supervise; whilst the guns, only able to move along roads, lanes, or open cavalry country, would either hamper the infantry movements, or under the protection of a strong escort be left in the rear, tending, perhaps, to block up the line of march for other troops.

Next, let us consider whether the objections advanced to "mitrailleurs being attached to battalions of infantry," equally apply to the case of cavalry regiments.

First, then, as regards the cost; this would be extremely small. Farriers, saddlers, drivers, mounted Non-commissioned Officers and men, horses, and a reserve of horses, are already there, though it would be advisable to have an extra armourer, and two at least of the saddletree makers should also be instructed as "wheelers."

The Serjeant-Instructor of Musketry should be made "Gun-Serjeant "Major," and could soon be qualified to instruct a given number of Non-commissioned Officers and men in each troop of regiments in which all ranks are already carefully practised in "aiming and judging distances." Supposing there to be a gun per squadron, a serjeant selected for this purpose would, for ordinary occasions, be in charge; but when the four guns were concentrated, the battery would be officered from the Captains and Subalterns who had taken first-class certificates at Hythe or Fleetwood, and of course should be specially drilled with those guns, and who would better understand how to give efficient support to the attack or retreat of their own arm than Officers of another branch of the service.

Now as to the general utility of mitrailleurs attached to mounted corps.

With cavalry they would be valuable for outpost duty, on exactly the same occasions as those previously enumerated with reference to infantry; and at night, when—as should almost invariably be the case—the cavalry piquets and videttes are withdrawn (these duties after dark devolving on the infantry), the mitrailleurs, with a proportion of mounted orderlies, should be left with the piquets or supports of the latter force.

A gun per squadron would also advantageously accompany strong "Reconnoitring Patrols" and "Patrols in pursuit;" and during a retreat, would render a rear-guard of cavalry comparatively independent of the other arms, particularly in the streets of towns and villages, where the front is necessarily restricted, and were the range is limited; also in roads and lanes, the flanks being covered by dismounted men.

Acting on the offensive, cavalry do not attack troops covered by impediments, but in an open country, where batteries of mitrailleurs are specially effective; and if well handled, they would give most effective support, for the Officers commanding them should manœuvre to occupy positions *within* 1,400 yards' range of an enemy's artillery, and *above* 1,000 yards distant from his infantry, availing themselves of natural cover such as undulations of ground, &c.

Admitting, then, that mitrailleurs attached permanently to cavalry regiments (not Lancers) would be both inexpensive and useful, the description of "machine-gun" best suited to the purpose must next be considered. It must be strong, yet so light as with a view to simplify driving, and for other important reasons, to be easily manœuvred with two horses, and over ground not practicable to ordinary artillery; it should hamper roads as little as possible, and be easily reversed in the narrowest lanes; should be capable of being worked by three men, and the ammunition waggon must carry the reserve rifle-cartridges of the squadron to which the gun is attached. It should be a "continuous-"firing," that is a "repeating-gun," so that it should not be necessary,—as with artillery,—always to have at least two guns in action at a time, one supporting the other; it should have no recoil, and should not require re-sighting or re-laying, but, firing a shot at a time, allow of a lateral, sweeping motion being kept up during firing, all of which requisites, I believe, are to be found in the "Gatling gun."

With the cavalry division in the Crimea there were three troops of horse artillery, and a half troop without guns, to carry the reserve carbine ammunition; had there been "Gatling guns" attached to regiments, two batteries and the half troop might have been spared by the cavalry, and employed as part of the Artillery of Reserve, where horse-artillery are so specially valuable.

The third question for argument is whether "mitrailleurs should "be formed into batteries of eight or twelve guns each, and should form "part of our artillery force." In reply, I am strongly inclined to think that as this would entail an establishment consisting of a first and second Captain, three Lieutenants, an Assistant-Surgeon, a Veterinary Surgeon, a Sergeant-Major, a Quartermaster Sergeant, &c., &c.,—in fact be nearly as costly as a complete battery of our present field-guns;—I would rather not replace them with mitrailleurs.

I may add that upwards of two years ago I suggested to a military authority that permission should be given for the experiment of the system of attaching "Gatling guns" to cavalry in the proportion of one to each wing, or squadron, being tried in the regiment under my command, and which was then, and is now, at the head of the cavalry as regards "musketry," all ranks being as carefully instructed in "dismounted practice" and the use of fire arms, as was compatible with the greater cavalry essentials.

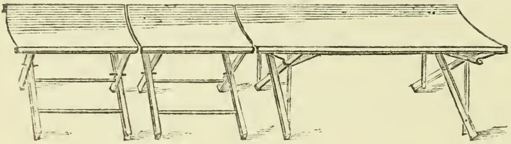
THE CHOBHAM CAMP BEDSTEAD, CONVERTIBLE INTO A TABLE AND TWO STOOLS.

Invented and described by Conrad A. Dillon, Esq., Captain 36th Middlesex Rifle Volunteers.

The patented invention which I have the honour to submit to you this evening is so simple in construction, and its uses are so obvious, that it hardly needs any remarks. It consists of three parts, a table and two stools, which, by a simple contrivance, are convertible into a camp bedstead. The great want which exists in camp, of a table of the ordinary height, with a stool in proportion, is beyond all question. Whether it be for writing or drawing, a table is almost indispensable, and the various makeshifts and contrivances hitherto resorted to, have never completely satisfied all the different requirements.

So far as the bedstead is concerned, it is, I believe, generally considered to be (though of course not a necessity) a most valuable addition for camp life, being the only real protection from damp and the ills which accompany it. Being disembarassed of one's bedstead during the day, in the confined space of a bell tent, is by no means a slight advantage gained by the adoption of this patent.

Fig. 2.



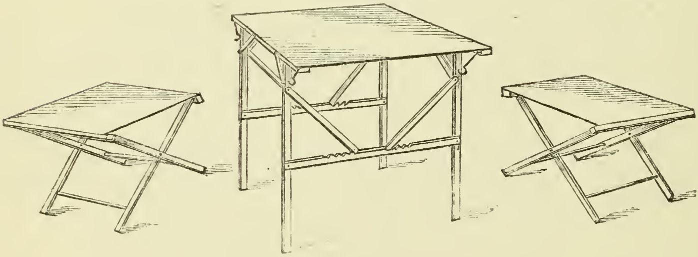


Fig. 1.

The table consists of a piece of canvas stretched tightly on two horizontal bars resting on four legs, which are connected by two cross-bars. The head is kept stretched by four struts fastened to the four legs, and working in notches on the cross-bars (Fig. 1).

For all the ordinary uses of a table, the canvas will be found sufficient; for drawing, a panel-drawing-board resting on the two horizontal bars will be found to make a table almost equal to any ordinary house table. Wooden mats, which will roll up, are also most convenient for making a stiff top to the table. The four legs are connected with the horizontal bars, into which they fit by means of a joint, like the ramrod of a cavalry carbine, and are made perfectly secure by four hooks. The cross-bars, the only loose pieces, connect the legs by means of screws, themselves permanently attached to their respective places. The camp stools are of the ordinary construction, as it is not considered advisable to sacrifice strength and stability.

To form the bed, the struts of the table are thrown out of gear, and the cross-bars taken off (Fig. 2). The legs are then crossed and made fast by the two screws which are attached to the outer legs. The hanging struts which are turned out, serve to support the stool thus formed, in case of any unusual weight being placed upon it. The three stools are then placed in a row, and connected by the couple at the ends of the horizontal bars.

The size of the bedstead is about 6 ft. by 2 ft., but it can be had any length required. The table is 3 ft. by 2 ft. 2½ in., and 2 ft. 6 in. high. The stools are 2 ft. by 18 in., and are about 18 in. high.

The total weight is about 20 lbs. (that is of these, which are of American Ash), but that of course can be diminished or increased according to the wood, the thickness of the canvas, and the strength of the couples. The dimensions of the whole packed for transport, are 3 ft. by 18 in. by 9 in., or about 3½ cubic feet which includes a large space available for bedding, clothes, &c.

The drawing-board weighs 3¼ lb. The German Mat about 5 lbs.

I have submitted the invention to several gentlemen of experience, and the only objections which have hitherto been raised, have been against the size and weight; in reply to which objections I may state, that I believe this to be the smallest and lightest form in which a stool, table, and bedstead are at present made.

In reply to questions, Mr. Dillon said that, on an uneven surface the legs of the bed could be driven into the ground, and as it was held together by iron couplings, there was no chance of its giving way. The cost was £2 5*s*.

The CHAIRMAN: We thank Mr. Dillon for exhibiting this ingenious contrivance; in the next campaign in England we shall perhaps see it in use.

Evening Meeting.

Monday, January 29, 1872.

Vice-Admiral SIR FREDERICK W. E. NICOLSON, Bart., C.B., Vice President, in the Chair.

NAMES OF MEMBERS who joined the Institution between the 23rd and 29th January, 1872.

LIFE.

Wharton, W. J. L., Lieut. R.N.
Griffiths, M. R. M., Lieut. R.N.
Dawnay, Hon. Eustace H., Lieut. Coldm. Guards.
Monck, Hon. Henry P. C. S., Lieut. Coldm. Guards.
Gordon, Lord Douglas W. C., Lieut. Coldm. Guards.
Acheson, Hon. E. A. Brabazon, Capt. Coldm. Guards.
Ossulston, Charles Lord, Lieut. Coldm. Guards.

ANNUAL.

Money, E. C., Capt. 87th Regiment.
Rawes, W. W., Lieut. R.A.
De Kantzow, Herbert P., Capt. R.N.
Brancker, William G., Capt. R.A.
Ormsby, Geo. F., Capt. 2nd Dragoon Guards.
O'Brien, A. V., Lieut. 60th Rifles.
Brownrigg, Henry S., Lieut. Rifle Brigade.
Alexander, Caledon J., Capt. Coldm. Guards.
Mackinnon, L. D., Lieut. Coldm. Guards.
Sich, Arthur J., Lieut. 2nd Middlesex Rifle Volunteers.

MODERN SHIPS OF WAR, AS ILLUSTRATED BY THE MODELS IN THE ROYAL UNITED SERVICE INSTITUTION.

By NATHANIEL BARNABY, Esq., Assistant Constructor of the Navy.

On the 11th May, 1859, the first English sea-going ironclad—the "Warrior"—was ordered to be built, and she was quickly followed by the "Black Prince," the "Defence," and the "Resistance." Their advent was the signal for the inauguration of a new Navy, in which wooden ships of the line and frigates could hardly hold a place. The "Gloire" and "Invincible" had at this date (May, 1859,) already been a year in hand, and the French had commenced, or were on the point of commencing, the "Magenta," "Solferino," "Couronne," and "Normandie." Yet so little had the change thus inaugurated been foreseen, that in this year (1859) and the year succeeding it, 1860, the following ships were launched or had their conversion completed as screw ships, viz., Ships of the line, "Victoria," "Howe," "Duncan," "Gibraltar," "Anson," "Atlas," "Prince of Wales," "Revenge," "Hood," "Conqueror," "Neptune," "Frederick William," "St. George," "Trafalgar," "Irresistible," "Lion," and "Queen." Frigates: "Immortalité," "Liverpool," "Newcastle," "Phœbe," "Severn," "Narcissus," "Phaeton," "Ariadne," "Galatea," and "Bacchante." And at the end of 1860 there still remained incomplete upon the stocks, or being converted, the "Prince Regent," "Defiance," "Bulwark," "Robust," "Repulse," "Albion;" "Zealous," "Royal Alfred," "Royal Oak," "Triumph," ("Prince Consort,") "Caledonia," and "Ocean," line-of-battle ships, and the "Bristol," "Glasgow," "Undaunted," "Arethusa," "Constance," "Octavia," "Aurora," "Endymion," "Dryad," "Tweed," "Belvidera," "Dartmouth," and "Ister" frigates; all these being designed to be built of wood, and unarmoured.

So late as January, 1860, a new classification of ships was ordered, of which the first, second, and third rates were as follows:—

First Rates.—All ships carrying 110 guns and upwards; and of which the complements were 1,000 men and upwards.

Second Rates.—All ships carrying under 110 guns and more than 80 guns; or with complements under 1,100 and not less than 800 men.

Third Rates.—All ships carrying 80 guns, or not less than 60 guns; and with complements under 800 and more than 600 men.

"Howe," "Duncan," and "Ariadne."

Among the ships which I have named as being produced at this period (1859-60) are three, models of which are in the Museum of this Institution, viz., the "Howe," "Duncan," and "Ariadne," of 121, 101, and 26 guns respectively. The cost of these ships complete, with the exception of ordnance and ordnance stores, would be represented by nearly £250,000, £200,000, and £150,000 respectively.

The armament designed for the "Howe" was 64 guns of 65 cwt. each; 34 of 56 cwt. each; 22 of 42 cwt. each; and 1 68-pounder pivot gun.

That designed for the "Duncan" was 38 guns, of 65 cwt. each; 38 of 56 cwt. each; 24 of 42 cwt. each; and 1 68-pounder pivot gun.

That designed for the "Ariadne" was 24 guns, of 84 cwt. each; and 2 68-pounder pivots.

I may be excused, I think, from giving any other particulars with regard to these ships further than to say that the "Howe" has never been completed for sea, and is now a divisional ship at Devonport; the "Duncan" is in the First Division of Reserve at Sheerness; and the "Ariadne" has just been completed as a training-ship for Cadets.

I ought, perhaps, also to say that the "Howe" has no sister ship; that the "Duncan" had or was intended to have the following sisters (not precisely identical, but nearly so) "Gibraltar," "Repulse," "Bulwark," "Zealous," "Robust," "Royal Alfred," "Royal Oak," "Triumph" or "Prince Consort," "Caledonia," and "Ocean." Of these seven have been cut down and converted into ironclads, and two are still on the stocks. The only sister ship completed, (the "Gibraltar") has just been lent to the Belfast Training-Ship-Committee for training poor Irish boys for seamen. The "Ariadne" has but one sister, viz., the "Galatea." Ten years ago, the ships of which these three models are representatives, were looked upon as perfect, and all the resources of our dockyards were taxed to the utmost to produce them. There were purveyors in every forest in England and in Italy, marking for immediate use the largest timber which could be found for stems, stern-posts and frames. In some cases the timber was worked into the ship only a few weeks after it had been standing full of life in the heart of the forest. To-day we regard them as ships of the past, obsolete, and nearly useless.

It may be that our prescience of to-day is no better than that of our predecessors, and that ten years hence, our works too may be obsolete. We should at any rate be careful, with this example before us, to forecast the future as accurately as we can, and to endeavour to secure and maintain our superiority on the seas, rather by the skilful and immediate appropriation of every modern improvement in our material of war, than by the mere multiplication of the numbers of our ships.

The late Controller of the Navy has, in my opinion, laid the English Navy under a lasting obligation for the boldness of policy in this respect which he inaugurated. He never hesitated to accept responsibility, and to risk failure when some new mode or device gave reason to hope that its adoption would add power to, or increase the efficiency of the Navy. There were doubtless some failures in the ten years of his rule, but I think no one can deny, that that period has been marked by an amount of success in novel and grand enterprises in naval construction, which is without a parallel in our history.

"*Warrior.*"

The first sea-going ironclad, the "Warrior," weighs, when complete, half as much again as the "Howe," and cost half as much again; her total cost, exclusive of ordnance and ordnance stores, being about £376,000. She carried when last commissioned, 32 guns, of which 28 were of 6½ tons, and 4 were of 9 tons. The number of her crew was 709 men, as compared with 1130 in the "Howe."

During the ten years which have passed away since the "Warrior" was completed, the power of armour-piercing guns has increased so greatly, that the 4½-inch plates with which she is covered through the middle of her length, can hardly be regarded as armour. Her plated side would be pierced by the 12-ton gun at 2,000 yards, by the 18-ton gun at 4,600 yards, and by the 35-ton gun at five miles!

"*Minotaur.*"

There was a defect, however, in the design of the "Warrior," and also in that of the smaller but similar ships, the "Defence" and "Resistance," for which no thickness of armour in the middle of the ship could compensate, viz.:—that the steering gear is unprotected by armour.

This was the special defect which led to the design of the "Minotaur," "Agincourt," and "Northumberland," in 1861.

In these ships it was sought to protect the hull throughout with armour of the same resisting power as that in the "Warrior," and "Defence" classes, preserving the speed of 14 knots at the measured mile. In effecting this, it was decided to increase the total weight of the ships by one-sixth, and to spend upon them £100,000 more money than the "Warrior" had cost.

These ships answered the expectations of the designers as fully as the "Warrior" had done; but they have never been held in much favour by sailors. One principal cause of this, is probably the unusual mode of masting, the sail being distributed upon five masts. This was done in deference to strongly expressed opinions of naval men; but it is unsightly and ineffective. They spread more sail than the "Warrior," the area of plain-sail in the "Warrior," being 23 times the immersed midship section, while in the "Minotaur," it is $24\frac{1}{4}$ times. The proportion of sail to weight of ship is the same in both cases. But as a matter of fact, no sail is ever spread upon the two-after of the five masts, and it is found that even under these circumstances, the ships carry considerable weather-helm. We are satisfied that no change in the disposition of the masts would remedy this evil, and it has therefore been decided to make no change in the mode of rig.

I should state that the "Northumberland" differs from her sisters in having the armour above the main deck omitted from the extremities, and confined to an enclosed battery somewhat less than half the length of the ship.

"*Hercules.*"

The ships of the "Minotaur" class, like the "Warrior," may be pierced by the 12-ton gun at 2,000 yards, but the next ship to be considered, the "Hercules," is impenetrable to this gun at all ranges; and also, along the belt amid ships, to the 18-ton gun, at ranges beyond about 250 yards. Comparing her with the "Minotaur," it may be said that for £100,000 less money, or for the same cost as the "Warrior," a ship is produced throwing $\frac{1}{8}$th more metal from the broadside than the "Minotaur;" having armour of more than double the resisting power; running at the same speed; and turning completely round in half the time. The drawback in this ship, as compared with her predecessors, is that whereas the "Minotaur" is propelled at full speed with 6,700 horse-power, the "Hercules" requires 8,500 horse-power to propel her at full speed. The speed is obtained in the former ships by fineness of proportion and form, and in the later ships, by high engine-power. It is to be remembered that this increase in power at full-speed does not represent a corresponding increase in the ordinary consumption of fuel, for in the first place the short ships are more manageable under sail, and require less steaming; and secondly, the ordinary working speeds are very low. The indicated power at these low speeds, say at 5 knots, would be, in "Minotaur" 562, and in "Hercules" 798, *i.e.*, the difference would be only 236 indicated horse-power at 5 knots speed.

As a matter of fact, the "Hercules" consumes much less fuel than the "Minotaur," because her engines are constructed on a better principle, the actual consumptions at 5 knots speed are, in "Minotaur," 4·28 lbs., and in "Hercules" 1·54 lbs. per indicated horse-power per hour. One ton of coal will carry the "Minotaur," 4·6 knots at 5 knots speed; while it will carry the "Hercules" 9 knots, or about twice as far.

"*Sultan.*"

The "Sultan" has the same bottom and the same thickness of armour as the "Hercules." But the arrangement of the armour above the main deck is altered. In the "Sultan," the main deck battery is lengthened 12 feet, and the after-embrasured and ports in it are abandoned as compared with the "Hercules." The armoured gun at the after-end of the main deck is also given up, and the after-fire is obtained from an armoured battery upon the upper deck, firing in a line with the keel. The armoured bow-fire is also changed, the single 12½-ton gun on the main deck of the "Hercules" being replaced by two 12½-ton guns on the upper deck.

While, therefore, the "Hercules" has ten protected guns, eight of 18 tons, and two of 12½ tons, together with four unprotected 6½-ton guns, the "Sultan" has 12 protected guns, viz., eight of 18 tons, and four of 12½ tons, and no unprotected guns, except of small calibre: The weight of broadside thrown by the "Hercules" from the guns named, is 1818 lbs., while in the "Sultan" it is 1965 lbs. The increase in the weight of the "Sultan" over the "Hercules" is 600 tons, part being in the form of armour in the upper part of the ship, and part in iron-cement between the two bottoms as a compensation for it. On the whole, the range of stability in the "Sultan" is even better than in the "Hercules," and her steadiness is nearly as great.

"*Monarch.*"

The "Monarch" is somewhat smaller than the "Hercules," her weight being 8322 tons as against 8677 tons in the "Hercules," and she cost as much money within £6000. The weights of hull in the two ships are within 100 tons of each other, and the weights of armour carried within 25 tons, but the armour in the "Monarch" is spread over a larger surface, and is therefore one inch thinner than in the "Hercules." The total weight of guns and ammunition carried, is in the "Hercules," 555 tons, and in the "Monarch," 478 tons, but the guns in the turrets of the "Monarch" are of 25 tons weight, while the heaviest guns carried by the "Hercules" are of 18 tons. The weight of broadside thrown by the "Hercules" is 1818 lbs., while in the "Monarch" it is 2600 lbs.

I will return to these two ships again after having described the next class, viz., the "Vanguard."

"*Vanguard*" *Class.*

These ships have both a main and an upper deck armoured battery, and command an absolutely all-round fire from 12 ton guns, protected by armour, while they are at the same time fully rigged.

There are properly six ships of this class, viz., the "Vanguard," "Audacious," Invincible," "Iron Duke," "Swiftsure," and "Triumph."

The four first named are alike, but they differ in some important respects from the last two. Above the water-line, the ships are almost precisely alike, and the offensive and defensive powers are nearly identical; but the "Swiftsure" and "Triumph" have single lifting screws, while the other four ships have fixed "twin screws." For this reason the draft of water of the "Swiftsure" and "Triumph," has been made two feet more than that of the other ships, and to enable them to keep the seas as cruisers for longer periods than the others, their iron bottoms have been covered with a double wood sheathing, and over this a copper sheathing has been laid. Their armament consists of six 12-ton guns in the main-deck battery, and four of the same kind in the upper-deck battery. They also carry four 64-pounders unprotected.

It is very difficult to express by a co-efficient the several elements which constitute efficiency in a ship of war, but the principal elements of fighting-efficiency in a sea-going ironclad may, I think, be said to be—

1. The weight of armour per ton of ship's measurement.
2. The weight of the protected guns and ammunition carried.
3. The height of battery port sills above the load-water line.
4. The speed in knots at the measured mile.
5. Handiness and quickness in manœuvring.

A co-efficient of fighting efficiency may be constructed from these elements, if the following assumptions are made:—

First. That the efficiency will vary directly as the first three of these elements.

If an objection is made against the third on the ground that in a turret-ship, the guns have the advantage of being withdrawn further from the water in rolling by being placed centrally, and that this advantage is not shown, it may be answered, that neither is the advantage possessed by the broadside ship of having a greater number of guns, and that these advantages may be set off one against the other.

Secondly. That the efficiency will vary as the cube of the speed.

This power of the speed is taken because the differences in speed among the ships compared, are very small, but even small differences may have great results in an engagement.

Thirdly. That other things being the same, handiness and quickness in manœuvring will vary inversely as the length of the ship.

On these assumptions we get the following measures of fighting efficiency:—

Proposed approximate measure of fighting efficiency in fully-rigged ironclads, as given by the expression $\frac{A \times G \times H \times S^3}{L \times 100}$

A is the weight of armour per-ton of ship's measurement.
G is the weight of protected guns and ammunition.
H is the height of battery-port-sills above load-water line.
S is the speed in knots, at measured mile.
L is the length of ship.

	Tonnage.	Complete cost of Ship, and exclusive of Masts, Yards, Rigging, and Stores.	Measure of Fighting Efficiency.
		£	
Monarch	5102	345,540	149·8
Hercules	5234	360,147	113·4
Captain	4272	330,000	83·3
Vanguard	3774	255,000	83·0
Minotaur	6621	430,000	61·1
Warrior........	6109	356,693	44·5
Defence	3720	223,055	10·9

The "Vanguard" class approaches nearest to the "Marengo" and "Ocean" class in the French Navy. But in the French ships, the guns in the upper battery are fought *en barbette*, and are dangerously exposed. Their armour also is so extended that, although they carry 1,280 tons of armour, as compared with 924 tons in the "Vanguard," and have 7·9 plates at the water line, the average thickness of the iron to be penetrated in the French ships is less than in the "Vanguard." The French ships weigh about 900 tons more than the English, but half of this is in weight of hull, where it adds nothing to fighting efficiency. There is also good reason to believe that the French ships are inferior in speed to the ships of the "Vanguard" class, and that the present nominal superiority in weight of broadside thrown, does not represent real superiority. Even on the assumption that the French 27 cm. gun has 1,150 feet initial velocity, which is believed to be greatly more than it has, and on the further assumption that the 24 cm. guns in the upper battery are protected as fully as those of the "Vanguard," which they clearly are not, we should have the following comparative energy per inch of shot's circumference in a broadside of the protected guns in each ship.

"Vanguard"	525
"Marengo"...........................	430

It is to be remembered that of these French ships, "Ocean," "Marengo," "Suffren," "Friedland," "Richelieu," "Colbert," and "Trident," only one is of iron.

Before passing on to the unmasted ships, it may be as well to compare briefly the "Defence" and "Resistance," of 1861, with the 'Vanguard," of 1871.

The two classes cost practically the same for hull and engines ; but on comparing them it will be seen that whereas, with a weight of hull of 3,730 tons, the "Resistance" class carries 607 tons of 4½-inch armour on 18 inches of wood, and a ⅝-inch iron skin ; the "Vanguard" class, with a weight of hull of 2,854 tons,* carries 924 tons of 8-inch and 6-inch armour on 12 inches of wood and on an 1¼-inch iron skin. In other words, with three-fourths of the weight of hull, there is an increase of more than one-half in the armour carried. While the ends of the former class with all the steering gear are unprotected, the latter class are completely protected throughout the hull, and the upper and lower batteries.

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* This weight includes the cement ballast.

The weight of the broadside thrown from protected guns is 1,250 lbs. for the former, and 640 lbs. for the latter. The speed of the two classes under steam is 13½ knots for the former, and 11¾ knots for the latter. The area of plain sail is 25,000 square feet in the "Vanguard" class, and 22,400 in the "Resistance" class.

To these facts is to be added the important consideration, that the former class has a double bottom throughout, and the latter for only a few feet on each side of the keel. It is to be observed further, in regard to handiness under steam, that the "Vanguard" class will turn completely round in 4½ minutes, and that the "Resistance" class require 7 minutes to complete a circle.

"*Devastation*" *and* "*Thunderer.*"

The "Devastation" is the first sea-going ship of war,—properly so called,—designed without sails. The American ships "Monadnock" and "Miantonomoh" carried only a very limited supply of coal, and were never trusted at sea without their escort; but the "Devastation" class are expected to be able to maintain an independent existence at sea for long periods.

Comparing "Monarch" and "Devastation" as to power of endurance under steam, we consider that the average distance which the "Devastation" may be expected to run at 5 knots speed, with one ton of coal, is about 5¾ knots, so that her 1,600 tons of coal would carry her about 9,200 miles.

The distance which the "Monarch" would be carried under steam alone at 5-knots speed, by one ton of coal, would be about 6½ knots, and if under sail with sufficient steam power to keep the screw going (as is always done when the ship is with the fleet under sail) about 11 to 12 knots. Supposing her to have favouring winds, so that she may use her sail in this manner half her time, and to be under steam alone the other half, then it may be assumed that she would be carried about 9 knots on an average by one ton of coal, and her coal would then carry her 5,400 miles only, as against the 9,200 of the "Devastation."

On comparing the resisting power of the armour of the two ships, we see that while the total weight of the "Devastation," including all stores, is only one-ninth greater than that of the "Monarch," the weight of armour carried by the "Devastation" is just twice as great as that carried by the "Monarch." The side armour of the "Monarch" might be pierced by the guns of the "Devastation" at 2¾ miles, the charge being 115 lbs. of pebble powder, and the weight of shot 700 lbs. But the armour of the "Devastation" is not penetrable at all by the guns of the "Monarch" if R.L.G. powder is used, and is impenetrable with pebble powder (85 lbs.) at ranges beyond 200 yards. The 14-inch armour on the front of the turrets of the "Devastation" would be impenetrable to the guns of the "Monarch" at any range, but the front turret armour of the "Monarch" would be penetrable at 2300 yards to the guns of the "Devastation."

I must not omit to state on the other side of the case, that the "Monarch" has two knots more speed than the "Devastation" is designed to have, so that while the "Monarch" could stand no chance with the "Devastation" in an engagement, she could always avoid one.

The chief difficulty to be apprehended in the ships of this class is the provision for a proper amount of light and air, as the ships will otherwise never be popular. I therefore attach very great importance to the superstructures recently added, by which we have been enabled to bring up all the ship's company and officers above the armour.

To compare the "Devastation" with the "Minotaur."

The hull of the "Minotaur" weighs more than her armour, armament, machinery, coals, and her whole equipment put together, while that of the "Devastation" weighs only half as much as her own. The armour of the "Minotaur" is equal to one-third of the weight of the hull which carries it, while that of the "Devastation" is ·83, *i.e.*, more than three-quarters of it.

The hull of the "Minotaur" is protected by 5½ inches of armour, that of the "Devastation" by 12 inches. The weight of guns and ammunition in the two ships is the same, but the weight of a broadside of the "Devastation" is 2,400 lbs, while that of the "Minotaur" is 1,600 lbs.

The "Devastation" will be worked by a crew of from 250 to 300 men, while the "Minotaur" requires 700; and the cost of the two ships exclusive of ordnance, and ordnance stores, is about £320,000 for the "Devastation," and £478,000 for the "Minotaur," which is a difference of more than £150,000.

The question for the immediate future of the English Navy is, to what extent this class of heavily armoured unmasted ships, combined with unarmoured-masted ships, such as the "Inconstant" and "Raleigh"—which I am about to describe—will render ships of the mixed class, *i.e.*, with heavy armour and sails, undesirable. I shall not discuss that question, but describe briefly the "Inconstant" and "Raleigh."

"*Inconstant*" *and* "*Raleigh.*"

Both these classes are built of thin iron like an ordinary iron ship, they are then sheathed with wood, and the bottom is coppered. They have very high speed under steam, and sufficient sail power to enable them to cruize without any expenditure of fuel. The "Inconstant" attained a mean speed on the measured mile of 16½ knots, and the "Raleigh" is expected to obtain 1 knot less. The armament of the "Inconstant" consists mainly of 12½-ton guns, while that of the "Raleigh" will consist chiefly of 64-pounders. The "Blonde," which is of nearly the same design as the "Inconstant," will have mainly 6½-ton guns and 64-pounders. The cost of the two types of ship—the "Inconstant" and "Raleigh"—will differ by about £40,000.

"Glatton" and "Cyclops."

I come now to the types of "coast defence ships," viz., the "Glatton" and "Cyclops" classes. The former has 12-inch armour on the sides, and carries two 25-ton guns, with a speed of 12 knots. The latter has 8-inch armour only, and carries four 18-ton guns, with a speed of 10 knots. The cost of the "Glatton" is within £50,000 of the cost of the "Vanguard," and exceeds the cost of the "Cyclops" by £70,000. The ships of the "Cyclops" class cost about £140,000 each for hull and engines complete.

I do not myself regard these classes as being such valuable additions to the English Navy as ships of the "Devastation," "Vanguard," and "Raleigh" classes would have been, and I am of opinion that when we are able to hold our hands in the production of such ships as those last named, and desire to organize "special coast defence," it can be done far more efficiently and cheaply than by an increase in the number of such ships as the "Glatton" and "Cyclops," excellent and powerful as they are. I consider that the "Cyclops" is nearly perfect as a ship of the particular type desired; and when the superstructures are added, they may be safely navigated to any part of the world. But, when designing for "coast and harbour defence" comes to be fairly considered, I am quite sure that the problem admits of an easy and comparatively inexpensive solution.

In all these cases I have called attention especially to the cost of the ships, because this is daily becoming of more importance. In modern marine warfare there are three modes of attack which are of a far more fatal character than any to which ships of war were formerly exposed, and a successful attack by either mode will probably lead to the foundering of the ship. The modes of attack to which I refer are, the "submarine gun," the "torpedo," and the "ram." And it is to be observed that the large and heavily-armoured ship is absolutely inferior to the smaller and weaker ship with regard to the attack of torpedoes and rams. The very hugeness and weight of the ships make them the easier prey to an enemy who attacks them below the armour.

From the under side of the armour belt, *i.e.*, from six feet under water to the keel, the ship costing £500,000 is as weak as the ship costing only £100,000; and she is more exposed to attack. So long as this is so, the most efficient ship is that, which on the smallest dimensions, will carry into action at a 13 or 14 knot-speed, guns capable of penetrating all but the exceptional armour of the ships of Foreign Powers, and protected by armour, proof to all but the exceptional guns of those Powers. It is in this aspect that the "Vanguard" class commends itself to my judgment.

If it should have appeared to you that I have expressed views not very favourable to some of the designs, I must ask you to remember that I do not appear before you as the rival of the designer in any of these cases. I have assisted in the production of every one of the ships I have described. I find that the original sheer drawings of the "Howe" and of the "Bulwark" class were made by my hands, and I have been more or less intimately connected with every subsequent design. I have therefore felt myself at liberty to criticise them all freely for your benefit.

I would call attention also to the fact that while I have pointed out the irresistible power of the "Devastation" as compared with the "Monarch" and "Hercules," the comparison would be still more to the disadvantage of the ships of Foreign Powers. I have pointed out for example that the most powerful ships in the French Navy, the "Ocean" and "Marengo" are inferior in fighting efficiency to the "Vanguard," and are therefore greatly inferior to the "Monarch," "Sultan," and "Hercules." Of these three last-named ships, Mr. Reed and Sir Spencer Robinson may be justly proud; and if there were no limit to our wealth of men and money, we could hardly imagine better types for the cruising ships of the English Navy; but as there is a limit to both, I have made it my business to consider how we can get most money's worth for our money, under all the possibilities of future European warfare on the seas. For this reason I have extolled, and I think justly, the "Vanguard" class for "rigged ironclads." I have also shown to what a large extent the abandonment of rigging increases the power and reduces the cost of "armour-clads," and I think you will agree with me that we ought to look to the sea trials of the "Devastation," which will come off—if all goes well—in the ensuing summer, with the greatest possible interest. I hope to have the opportunity myself of watching her behaviour in the open seas in bad weather, and I may have the pleasure of reporting her complete success to you here before the year 1872 is ended.

EXPLANATION OF DIAGRAMS.

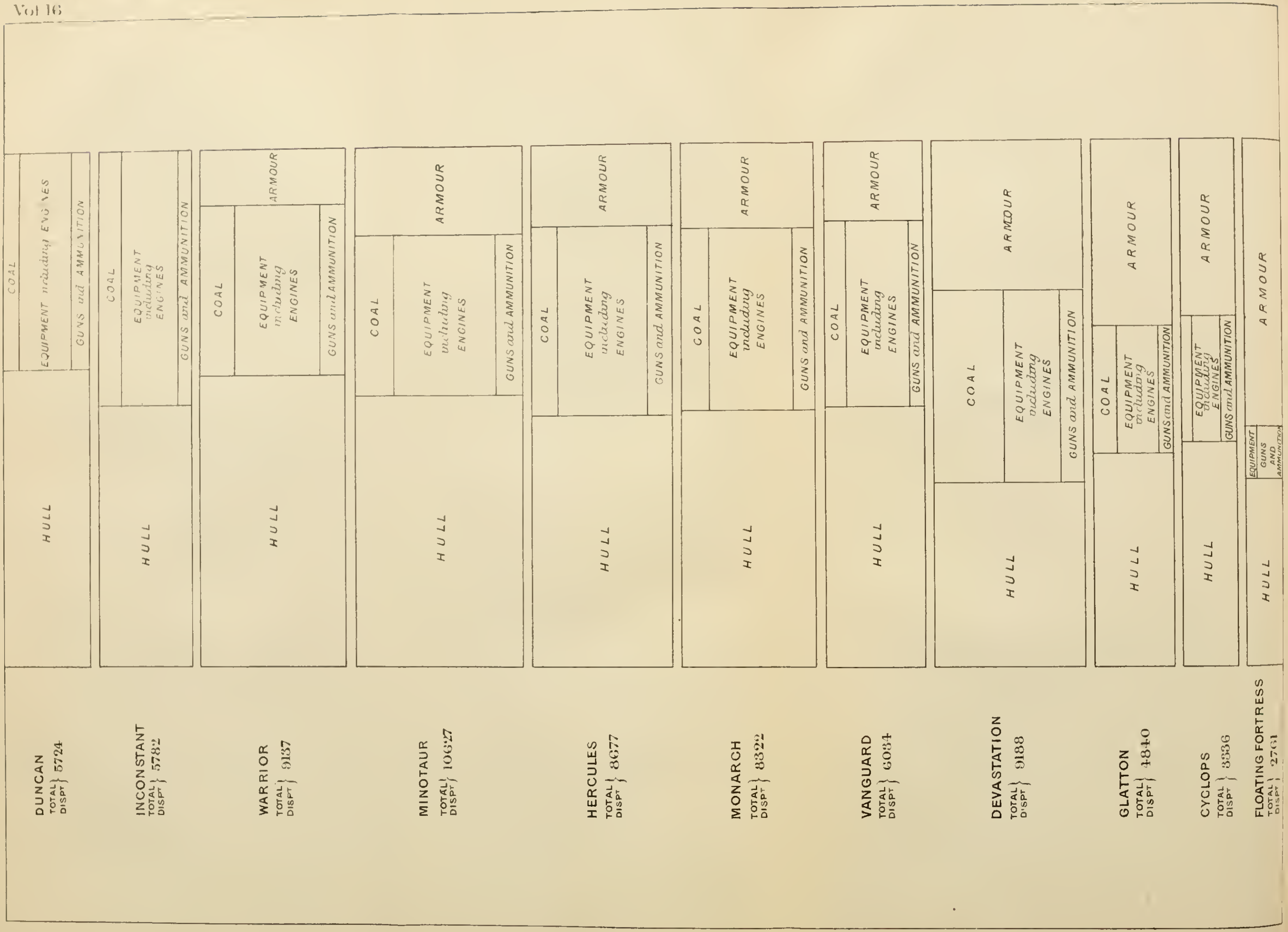
Armour and Gun Diagrams.

These must be understood to have no other authority than my own. They have been prepared for my own use from the records of the Shoeburyness experiments, and are as accurate as careful collation of experimental results, and calculations founded thereon by the ordinary formulæ can make them.

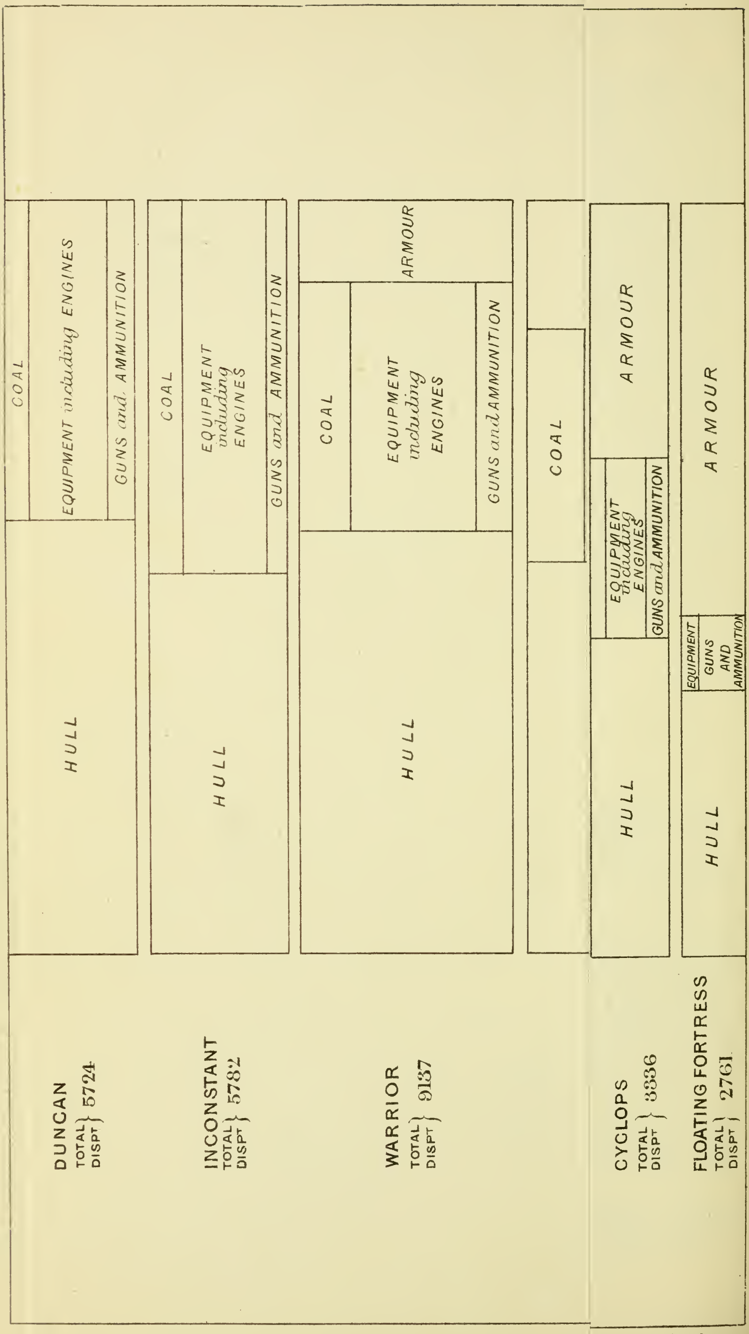
Fig. 1 (Plate III). Represents the resisting power of armour plates of various thicknesses up to 18 inches. It is in general agreement with the results of all experiments made up to this date, and appears to confirm the impression entertained by many gunnery Officers that for thicknesses up to about 7 inches the resistance of a plate varies with the square of its thickness; and that for thicknesses above 10 inches, the resistance varies directly as the thickness.

Fig. 2. Represents the penetrating powers at various ranges of the 12, 18, 25, and 35-ton guns, against armour backed as in Fig. 1, viz., with 10 inches of wood between longitudinal girders, 1½ inches of skin plating, and frames 2 feet apart.

A represents the 12-ton gun with 43 lbs. of R.L.G. powder: B the 18-ton gun with 60 lbs. of R.L.G. powder: C the 25-ton gun with 85


DUNCAN TOTAL DISPT 5724
COAL
EQUIPMENT including ENGINES
GUNS and AMMUNITION
HULL
INCONSTANT TOTAL DISPT 5782
COAL
EQUIPMENT including ENGINES
GUNS and AMMUNITION
HULL
WARRIOR TOTAL DISPT 9137
ARMOUR
COAL
EQUIPMENT including ENGINES
GUNS and AMMUNITION
HULL
MINOTAUR TOTAL DISPT 10627
ARMOUR
COAL
EQUIPMENT including ENGINES
GUNS and AMMUNITION
HULL
HERCULES TOTAL DISPT 8677
ARMOUR
COAL
EQUIPMENT including ENGINES
GUNS and AMMUNITION
HULL
MONARCH TOTAL DISPT 8322
ARMOUR
COAL
EQUIPMENT including ENGINES
GUNS and AMMUNITION
HULL
VANGUARD TOTAL DISPT 6034
ARMOUR
COAL
EQUIPMENT including ENGINES
GUNS and AMMUNITION
HULL
DEVASTATION TOTAL DISPT 9188
ARMOUR
COAL
EQUIPMENT including ENGINES
GUNS and AMMUNITION
HULL
GLATTON TOTAL DISPT 4840
ARMOUR
COAL
EQUIPMENT including ENGINES
GUNS and AMMUNITION
HULL
CYCLOPS TOTAL DISPT 3336
ARMOUR
EQUIPMENT including ENGINES
GUNS and AMMUNITION
HULL
FLOATING FORTRESS TOTAL DISPT 2761
ARMOUR
EQUIPMENT
GUNS AND AMMUNITION
HULL

J. Jobbins


DUNCAN TOTAL DISPT 5724
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WARRIOR TOTAL DISPT 9137
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CYCLOPS TOTAL DISPT 3336
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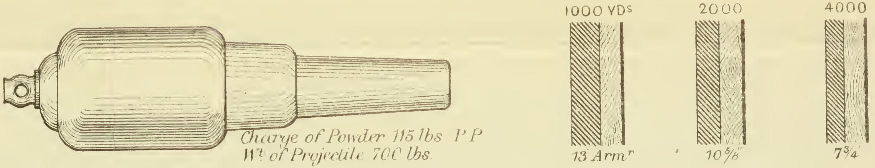
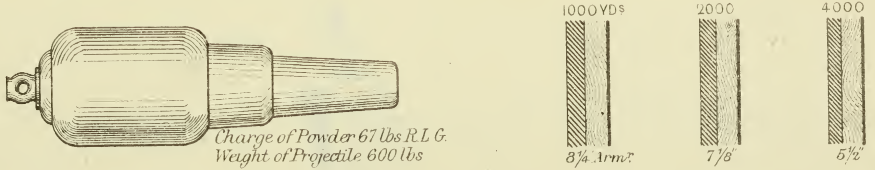
35 TON GUN
of 12 in Bore



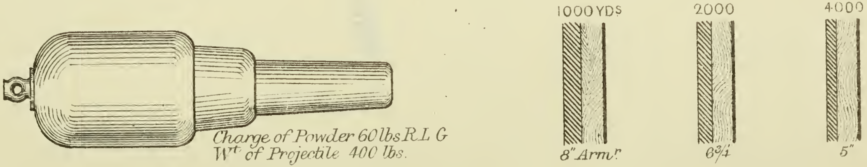
Charge of Powder 115 lbs P P
Wt. of Projectile 700 lbs.

25 TON GUN
of 12 in Bore.



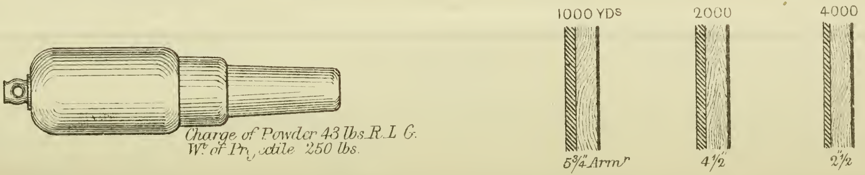
Charge of Powder 67 lbs R L G.
Weight of Projectile 600 lbs

18 TON GUN
of 10 in Bore



Charge of Powder 60 lbs R L G
Wt. of Projectile 400 lbs.

, 12 TON GUN
of 9 in Bore



Charge of Powder 43 lbs R L G.
Wt. of Projectile 250 lbs.

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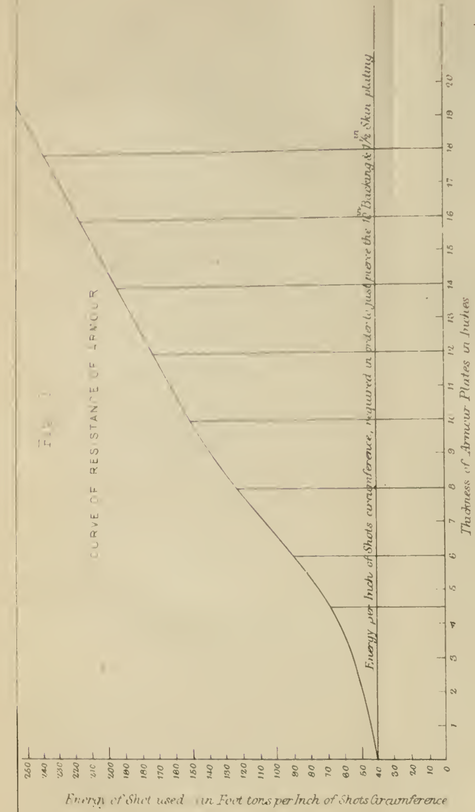

Fig 1

CURVE OF RESISTANCE OF ARMOUR

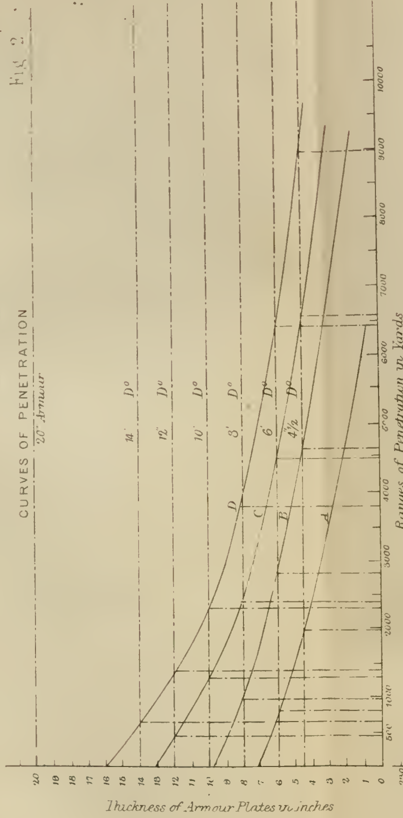

Fig 2

CURVES OF PENETRATION

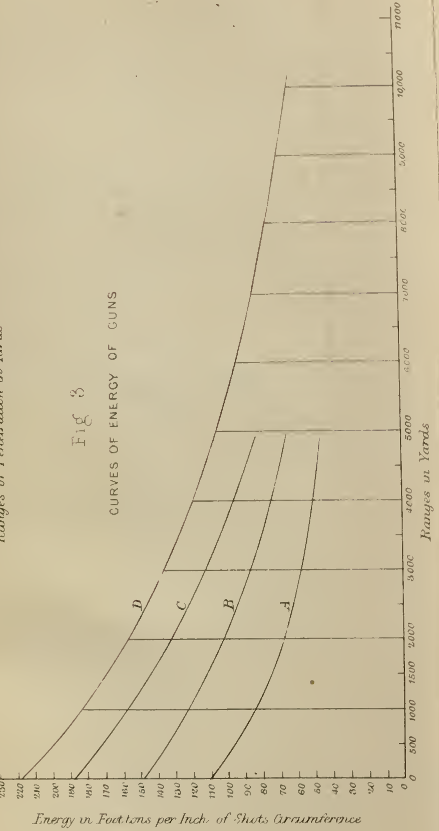

Fig 3

CURVES OF ENERGY OF GUNS

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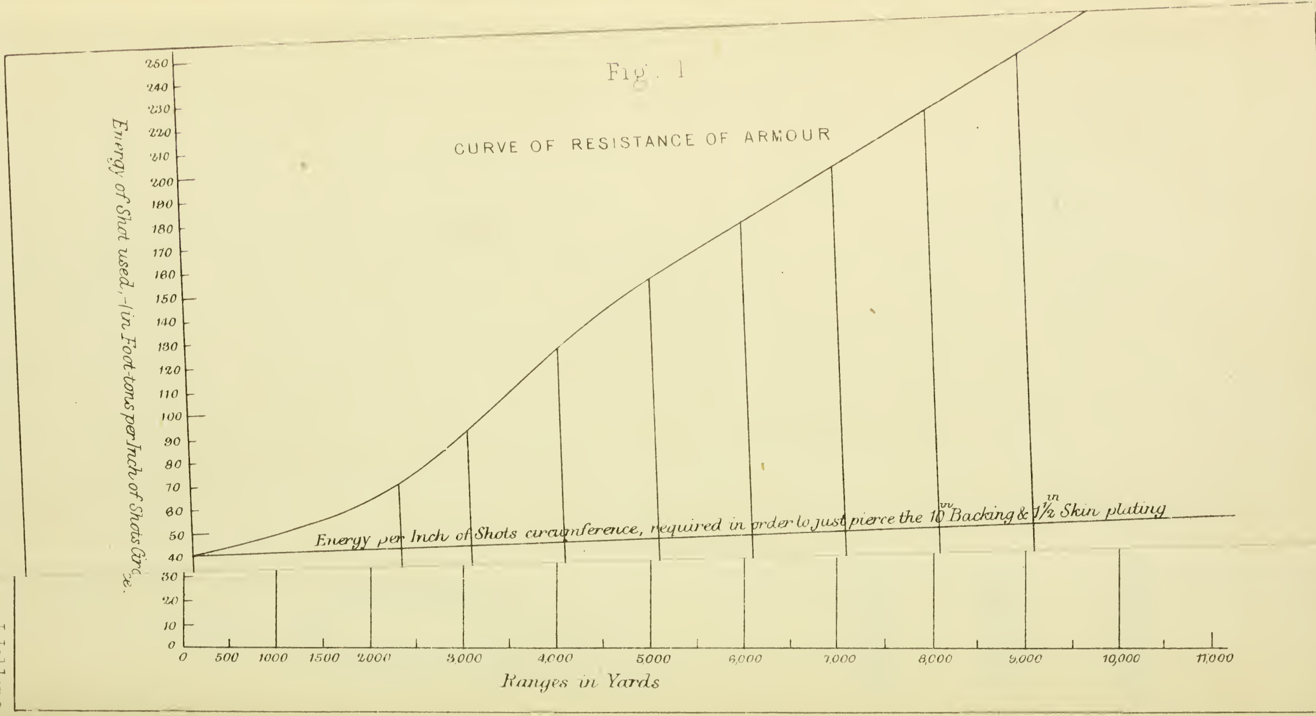
Fig. 1



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lbs. of pebble powder: and D the 35-ton gun with 115 lbs. of pebble powder.

Fig. 3. Represents the energies of these same guns at various ranges.

It will be seen that by means of Fig. 1, it can be readily ascertained what thickness of armour a shot of known weight, diameter, and velocity from any gun will penetrate, the energy of the shot in foot-tons per inch of circumference being $\frac{Wv^2}{2gc}$ where W is the weight of the shot in lbs., v its striking velocity in feet per second, g is 32·2, and c is the circumference of the shot in inches.

By means of Fig. 2, the ranges at which the principal English guns will penetrate armour, backed as supposed, can be ascertained; but it is to be observed that the wooden ironclads of France and other countries have nothing corresponding to the 1½ inches of skin-plating, and their resisting power must be reduced on this account.

Fig. 3. Furnishes the means of ascertaining the penetrative power of the guns named at various ranges, against other arrangements of armour than that supposed, a curve similar to Fig. 1 being constructed from the result of experiments with guns of known energy, against such differently formed targets.

The diagram (Plate IV) representing the heavy guns themselves shows the armour which can be just perforated by these guns, at the several ranges named, under the conditions given above.

Displacement Diagrams.

These diagrams (Plate V) furnish a graphic representation of the comparative weights of the completed ships, the areas of the rectangles being in all cases in proportion to the entire weight or displacement.

All the diagrams are made of the same length in order to show clearly the variation in the proportions of weight of armour, equipment, and hull, to the entire displacement in the several ships. The smaller rectangles into which the principal one is divided, are in exact proportion to the weights of the parts named.

Captain WHEATLEY, R.N.: We had a very interesting paper the other evening from Captain Colomb on "the Attack and Defence of Fleets," and we also had a very good speech from a young officer (Lieutenant Grenfell), who was one of a party of officers who have formed an Association at Portsmouth to discuss naval subjects. In Captain Colomb's paper it was very clear that the attack must, in all circumstances, whether the line be formed "head and stern" or "abreast" be made "end-on." The question was asked—In case of meeting an enemy's fleet, say the Russian fleet, which has a torpedo on each side of every ship, how is that fleet to be attacked? There was no answer. That same young officer stated that, when falling in with our fleet of evolution, the question arose among his shipmates—Supposing that is an enemy's squadron, how are they to be attacked? There was no answer. It appears from this, that guns on the broadside are comparatively of very little use, and as the attack must be "end-on," it requires a powerful battery both ahead and astern. I had the honour of bringing forward last April a different form of ship from any that has been produced here;

not a very new form, because it is founded on perhaps the oldest form of sea-going ships, the ships of the East. But to have a very heavy battery ahead and astern, you must increase the beam, and the beam can be increased in certain proportions without decreasing the speed. Now, an enemy's fleet at sea unopposed,—as we are in our island, which does not afford sufficient subsistence for the population,—would be more fatal to us than a landing on our shores. Our commerce is our life, we cannot do without it. The ship that I proposed brings eight 35-ton guns to fire in line with the keel either ahead or astern. She has also a projecting bow. She would be able to bring a torpedo against another ship sooner than a ship of any other form could bring one against her, and that is the only solution of the question, the question of two ships meeting, which shall first bring her torpedo to strike against the other? Now, the sloping bow with an outrigged torpedo along its upper slope which would project forty or fifty feet beyond the bow, and be about eight or ten feet under water, would give the torpedo its greatest power. The projecting beak being only from 8 ft. 6 in. to 7 ft. 6 in. above water, would tow a Harvey torpedo on each side with only three or less than four fathoms of tow line. Any other form would require from forty to fifty fathoms to bring it to bear under water. Therefore, I think that the form deserves a little more consideration than it has yet met with. I should like to add a few words about the loss of gun power in our ships. I saw in the newspapers that an American Rodman gun of 35 tons had been landed at Constantinople. This, of course, is a smooth bore. They have not yet adopted the rifled gun, and I think, however well the rifled gun may answer on shore, we have a great loss in not keeping to the smooth-bore at sea. I was not in the service when we had a war with the Danes in 1811 and 1812, but I have been with officers who were employed there. They said the gunboats always engaged beyond point-blank range, and when they saw a shot come splashing along the water, they were sure they were going to be hit. With the rifled gun, where the range is undergoing constant change, you cannot make sure of a hit; but with the ricochet which you have with the smooth-bore shot you are pretty sure to hit. Thus you lose by the rifled gun. Another loss you have. Unarmoured ships have been talked of for rams and torpedoes. By loading these large guns with grape, you increase the chances of hitting eight-fold; and one single shot penetrating the engine would disable any unarmoured or light-armoured ship, whether torpedo or ram. *

Commander W. Dawson, R.N.: I think we ought to congratulate Mr. Barnaby on the exceedingly valuable paper which he has brought before us, and the exceedingly candid way in which he has discussed and criticised very fairly what may be called his own productions, being those of the Admiralty during the last ten years. I am sure that anybody who will examine the new ships at the outports, will be struck with the extreme ingenuity which characterises all their different parts, and the many and great novelties that have been introduced. They reflect the grestest credit on the Constructive Department of the Admiralty. I say so most unreservedly, though I am not usually an indiscriminating admirer of every new thing I see, but am, generally, inclined to criticise very sharply those things that do not agree with my own notions. Mr. Barnaby has also brought before us some information on points which it is exceedingly difficult for a naval man to get acquainted with, such as the ruling principles which have guided the authorities in putting certain classes of ships into our hands. It is important that we should know what are the intentions of their constructors, if we would gather some idea of the best use to which these ships are expected to be put, and how we are supposed to employ them. For unless we can obtain such information as to the aims of those who constructed them, as Mr. Barnaby has given us, we really have not the basis to go upon in deciding the principles on which all future naval tactics should be based, or naval battles be fought. There are some controversial points connected with these ships that I confess I should like to have some little information upon. I merely allude to it now, not to raise a controversy, but in order that Mr. Barnaby

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* I did not mention it in the remarks I made as above, but I take it that a 35-ton smooth bore could have a bore of 18 inches diameter, and throw a solid shot of 800 lbs. As grape, a cluster of 12 50-lb. shot, with bar and disc, would weigh over 600 lbs.

may explain to us the view which the Constructive Department take of points that have been often discussed elsewhere. One difficulty is about putting "ballast" and "cement" in the bottom of ships of the "Vanguard" class. Why was not the additional weight put in in the shape of thicker iron plates, which would add to their strength, instead of "cement" ballast? He understands the controversy. I do not wish to enter into it, but only ask for information. The armament of the "Vanguard" class is far below modern requirements, and seems based on the fallacy that their own armour, and not that of the enemy, should govern the power of their guns. They ought to carry 18-ton guns. There are some of these classes of ships that I dislike very much; one is this modern low freeboard class for coast defence. What on earth do "coast defence" ships mean? In criticising these low freeboard ships, I am not criticising the Constructive Department of the Navy, which is simply the servant of the Board of Admiralty for the time being, obeying the orders it receives from its superiors. A former Board of Admiralty, whose members are deservedly held in high esteem, ordered these "coast defence" ships to be built. One of their number, an officer whom we all respect, whose opinion I hold in the highest estimation, told us in a letter to the *Times*, that the Constructive Department were ordered to construct ships that could be easily run over in mid-ocean, which could not possibly float in shallow water, that could not go from one port to another except after careful study of the barometer, that could go to the bottom readily in a very heavy sea-way, and in a variety of other ways, and that possessed the smallest amount of offensive power, and the maximum amount of defensive power against artillery. That problem the Constructive Department of the Admiralty have solved very faithfully and exceedingly cleverly, in giving us "coast defence" ships which cannot defend the coasts, and "harbour defence ships" which cannot move about our harbours. If they came across a lumbering merchant-ship at night, keeping a bad look-out, it is very likely they would be run over, and would go to the bottom. As to what would occur in a naval action, when hostile ships tried to run over them, is easily conjectured. Hostile ships would either overturn them, or else they would run up one side of them and send them down. I have got some recollection of serving in small craft in the Chops of the Channel in my younger days; and at night, in anything like a breeze or a sea-way, we always loaded our largest gun with a heavy charge, in order to frighten any merchant-ship that we feared might run over us. The same thing might happen to the "Glatton," the "Cyclops," and vessels of that class. If they cannot venture with safety into open water, I do not know what purpose of war they are meant to serve. They draw too much water for harbour defence, and if there was water enough for them in the harbour, high-sided ships could follow them, and instead of defending the harbour, they would have to look out to prevent themselves being run over. Now, an unarmoured vessel, a gunboat, would carry the same weight of guns that either the "Glatton" or the "Cyclops" carries, and yet be of small tonnage; probably a vessel of 400 tons would carry either ship's armament, and would draw very few feet of water. Such a gun-vessel would be able to go into shallow waters, and get out of the way of bigger ships, and would not be able to go to the bottom when at sea by being unseaworthy. I must protest most strongly against unseaworthy ships being wilfully designed. The British Navy has no place for an unseaworthy ship. A ship that would be likely to go to the bottom in sight of land because of the barometer falling, ought not to be built at all. We had an example a few years ago of one small ironclad being sent from Plymouth to Cork, and being compelled to put back; the Commander reported that it was only by a "merciful interposition of Providence" that ship and crew did not go to the bottom. I say it is morally, politically, and professionally wrong to put men into a ship that cannot go from Plymouth to Cork without the risk of going to the bottom. Whatever the size or denomination of our ships, they ought to be, before all things, perfectly seaworthy; and if they are fit to go from Plymouth to Cork, they would be safe to go anywhere else. That is the only class of vessel against which I wish to protest in strongest condemnation. They are neither seaworthy ships, fit to take part in a general action, nor are they safe enough for coast defence ships, nor is their draught of water suitable for harbour defence. We do not want ships to go up and down the Medway, the Tamar, or the Thames; that is not the purpose for which England wants war ships. As to the "Devastation," she is not half built yet, and I have not seen the drawings, so that I am unable to form an opinion as to this novelty in naval designs. I reserve my views upon that class until I am better informed as to their construction and qualities. Then, in the new designs, I notice also that there seems to be no provision for the use of the torpedo, though that weapon has been adopted in the Service for several years. We have made provision for using the "ram," but we have not recognised that the torpedo has been adopted in the Navy for the last three or four years, and that the best defence against hostile torpedo-ships or rams, is the employment of that weapon also. No provision has been made for employing torpedoes as a means of defence. Every class of ship should be able to make use of the torpedo, as her best defence against naval torpedoes and rams; provision for the safe handling of this defensive weapon might easily be made without adding to the weight of the ship.

Capt. Hoseason, R.N.: I am sure we are excessively indebted to Mr. Barnaby for bringing this important subject before us; it is, however, perfectly impossible to express an opinion upon so valuable a paper on hearing it read for the first time. I shall, therefore, content myself with making one or two observations. Mr. Barnaby observed that we continued to build wooden ships long after the properties of iron ships were well known, this is a fact, but the true cause Mr. Barnaby has not even hinted at, viz., that the "Megæra" and "Simoom," ordered to be built in 1843 or 1844, were intended for men of war; in the course of their construction, the necessity for a more searching test as to the applicability of iron to the purposes of war, was suggested to the then First Naval Lord of the Admiralty, and that the experiment should be tried against the section of a strong riveted side of a steamer, to create as much concussion as possible. A target of this nature was constructed, and the Board of Admiralty went to Woolwich to witness the experiment; the first shot fired, shivered the target to pieces, a splinter wounding a sentry two hundred yards distant. This important experiment passed off at the time quietly, and the "Megæra" and the "Simoom" were converted into "transports;" this formed the nucleus of the present very inefficient "transport-fleet." In 1849, or five years after, a hue and cry was raised by the late Admiral Sir Charles Napier and Admiral Sir Maurice Berkeley, in Parliament, against the previous Government, for having constructed vessels of iron, and elaborate experiments were carried out against iron targets at Portsmouth on board the "Excellent." These experiments threw no new light on the question, but left it in the same position, as after the Woolwich experiments in 1844. Thus, to serve a political purpose, the best interests of the country were sacrificed, and the introduction of iron for the purposes of naval construction was retarded for years, as has been stated by Mr. Barnaby.

It is impossible to accept the formula Mr. Barnaby shows on the board as a correct measure of the relative efficiency of the ships he has compared; mathematics are only a symbolic manner of reasoning, and as in logic, if false premises be advanced, false conclusions are arrived at, so any incorrect factors in such a computation are sure to lead to error. I object to the velocities stated, and to the source from which they have been obtained, and I contend that when thus cubed and introduced into the formula, they will never give a correct relative measure of the efficiency of the ships.

Captain Colomb, R.N.: I merely wish to add one word to say to Mr. Barnaby what he no doubt has observed, that his paper has not been very closely criticised. I have noticed in this theatre that the more exhaustive and the more complete the papers are, the more the meeting is in agreement with the lecturer's views, the less is the discussion, and the less is it to the point. I think Mr. Barnaby must take it that the naval members present are generally in accord with the views he has expressed. The navy owes a debt of gratitude to him for coming forward in this way, and for giving us information which, I for one, have never before seen in such complete form as I see it before me now. It is information of a kind which I have been anxious to get, which I have written to Shoeburyness for, and which I have tried in many ways to collect, and have been unable to do so. I was not aware that Mr. Barnaby had it all in his own head, or I should certainly have come to him for it. I have only risen to offer my very sincere congratulations to him, and to thank him for the lecture he has given us.

Captain FREMANTLE, R.N.: I think it is quite clear that we have had a very able, instructive, and suggestive lecture. We come here to improve upon the suggestions that are made to us. Some very valuable suggestions have been placed before us, and it is a great pity that we have not confined ourselves a little more to the point, or endeavoured to improve upon the suggestions thrown out. There was one suggestion of great importance as to the proper size of our ships, and the way in which they should be defended against torpedoes. That is one point. There is no time to do more than allude to these subjects, but in any case I could wish that other gentlemen who are better versed in such matters would undertake the task rather than myself. I merely allude to these points in passing, and would fain hope that they may be subjects of thought to us in future. Another question of great importance which Mr. Barnaby placed before us, and although he said he would not deal with it, yet he certainly gave us an insight into what his own opinion was as to whether it is advisable to have what we may call composite ships, ships built to carry very heavy armour, and to go at great speed, and at the same time to have masts and sails; whether, in fact, we can combine what used to be understood as "full-sail-power" with a large amount of armour. Now these are suggestive subjects, and I confess it appears to me that Mr. Barnaby is right when he seems to consider that the "Devastation" class, and ships of that sort which are built entirely for steam, without any sail power, are likely to supersede the composite ships of the "Monarch" and "Hercules" class. Another important subject on which he touched was the question of cement in the bottom of ships. Captain Dawson referred very properly to it as to whether we could not replace that cement, which I understand in the "Sultan" amounts to about 495 tons, by something in the shape of armour-plating, which might be sufficient to have some effect, at all events in resisting the impact of the torpedo. These are some of the subjects which Mr. Barnaby did touch upon. There are some which no doubt he was obliged to leave out. They probably would have involved too much discussion, and one cannot be astonished that he did not choose to deal with them. One of these is the question of stability. It has been dealt with before in this theatre, but it would have been of importance and rather satisfactory if Mr. Barnaby could have displayed something like the curve of stability of those ships. We see the great advance which has been made between the "Defence" and the "Captain," as far as fighting power is concerned. We see that the co-efficient of one is represented by 10·9, and of the other by 83·3. We know the "Captain" went to the bottom, and we know the "Defence" has not done so. That appears to me to be a very important point, but I am not prepared to say that anything like stability could have been added to that formula to make up those figures which he has given us on the board. However, it is decidedly an important point, and as an important point, it is a pity the time does not allow of its being dealt with at all. There is another thing which is not alluded to by Mr. Barnaby, which is also a subject of great importance. It is noticed by Mr. Reed in his "Iron-clad ships," that is, we want, very much, further experiments with the torpedo. Mr. Reed tells us that he has built his ships with double bottoms and with water-tight compartments, on purpose that they might resist the attack of these infernal machines. But he has told us at the same time, that no experiments have been made as a test in the slightest degree. We understood some little time ago that an old iron steamer had a double bottom given her, with the view of testing this question, when it was discovered by somebody that the line of least resistance would be taken by the explosive, therefore the whole of her double bottom was likely to be blown out, and that as a test the experiment would be useless, and nothing has been done in this direction. There is one other subject I should like to allude to, which Mr. Barnaby did not touch upon, that is the question of the number of guns. We all know that the number of guns has a great deal to do with the power of a ship. It has been pointed out by Mr. Reed in his "Iron-clad ships," in a little figure which he gives us, the advantage which the "Hercules" will have with a considerable number of small guns over a ship like the "Monarch," or "Captain," with a few large guns. That is a point which was dealt with by Captain Colomb last year. It is a question whether that could not have added to the formula as part of the co-efficients, for it is clearly an important point in calculating the power of ships.

Captain SELWYN, R.N.: I am going to ask for a few minutes, not to carp at, or indeed to do anything else than praise the most lucid and able manner in which this lecture has been brought before us. But there are some points on which I think that a free discussion in this theatre may strengthen rather than weaken the hands of those who have the power of carrying useful improvements into effect, and to those I should wish principally to advert. I am delighted to see that to the speed has been given a very high function in that mathematical equation which, however it may be deficient in some of its parts, is probably the nearest thing we have yet had to some measure of each ship's efficiency. I understood Mr. Barnaby only to mean it in that direction; it was something by way of giving us an idea of the comparative efficiency of vessels. But I feel, and Mr. Barnaby feels, as strongly as I do, for I have talked with him on the subject, that we have a power now thoroughly carried out and proved, and I believe proved for the first time, in one or two of the latest coast defence vessels that will materially increase the speed, provided that we cease to be afraid of attaining a little increased pressure in our boilers, which is, in fact, the foundation of the success of what are known as "compound engines." I have crossed the Atlantic twice within the last six months in one of the national line of steamboats, a vessel which would formerly have used something like thirty tons of coal per day, and which now uses less than fourteen tons, simply from the adoption of the "compound engines." It is quite possible to do that in the whole Navy. It has been done in some few vessels, and I hope to see it thoroughly carried out. Then the questions which relate to the ignoring of sails and the adoption of steam alone in those vessels of a certain class, which are only intended to defend our shores, will receive a very great simplification. We shall not be afraid then to trust to the steam power we carry, and to use it alone and entirely. We shall not attempt to combine a form which is really unfitted for shallow waters with a superstructure like that of the breastwork monitor, of which I can only say that it appears to have been built up by a succession of afterthoughts, in which it is even at last necessary for the safety of the vessels that they should have an afterthought of outside skin, to prevent the inside portion being immersed too deeply for safety. We shall not then any longer hesitate in defining our classes of vessels distinctly. For all purposes of coast defence there are two useful classes of vessels—a light boat, which may carry one gun of extreme weight and extreme charge, steam launches so to call them, attached to a particular port, manned and used by the Naval Reserve men of each district, and by no other persons, thoroughly well known by them, capable of being called rapidly together from the different outports by telegraphic communication to any point of the shore threatened; and the "floating forts." We may well call them "floating forts," for that is the true definition of all vessels intended for coast defence, utterly and totally distinct from those vessels which are intended to carry on communication with distant shores to enforce the respect due to our flag, wherever that is carried, and which must not only be habitable, but pleasurable and healthy habitations at sea. Our sailors must be able at sea to take a pride in our vessels, and we must be prepared to defend our shores with the energy which belongs to our race. If we seek for speed, and speed alone, by means of large fuel expenditure, we shall possibly commit an error. But when we have got speed by means of improvements in steam, such as I have spoken of, when we are able to combine speed with what in horse racing is denominated "bottom," then we see our way towards giving up sails, except in very fair winds having a very small quantity of sails for that purpose, only using them when the wind is strong, and giving up all idea of beating to windward and bracing up the yards as a waste of time and money, because, however fond I am of my profession, I do say that nothing can stand against the test of utility. If you have to spend more money to produce a certain effect, then you must give up the idea of doing it in that way, however beautiful you may have learnt to consider it. Here I remark with great pleasure the enormous advantage which has been shown on that board, however the figures may be in error, because, although the figures used, do not give the actual speed at sea, yet it will be seen that the errors are proportionably applied to all, therefore the results are still exact. (The CHAIRMAN: They are merely comparative.) They are comparative numbers. There has been a remarkable advance, when from 10·9 efficiency, we can go up to 149·8, with a difference of only £100,000 in the cost, and 2,000 in the tonnage. It shows a very great advance, but I should like to see that advance made in another direction. I should like to see an abandonment at once of all ideas by which the "floating fort" is calculated to be propelled by outside screws, and consequently to have deep draught of water, in favour of those plans which you had placed before you by the late Mr. Elder. I should like to see Captain Moncrieff's hydro-pneumatic arrangement for guns understood and appreciated, an arrangement by which the guns are carried low down in all weathers, by which they are thoroughly armoured, by which the armour can be placed where it is wanted, and not where it is of no importance. It matters nothing to us if the ship is pierced above the water line, you can easily close those holes when made, by simple applications, as long as the crew at their quarters are protected sufficiently. That is all we want. We do not want anything more than high coal-carrying power, great speed, which is to be obtained, I think, in these coast-defence vessels on the light draught given by the "elliptic section;" in the small launches, by the adoption of such improvements in the material of which they are built, and in their forms, as have been instanced most remarkably in a small vessel in which I had the pleasure of making a trip within the last few days, Mr. Thorneycroft's launch; she does nineteen miles an hour, with a draught of three feet. (The CHAIRMAN: She is made of steel.) She is of steel, or rather steel she will be called until people begin to understand that steel is really nothing but good iron; that is, all that steel is in the present day. I hope everything that may be said in this Institution on such occasions as these will be said with the view to strengthen the hands of those whose responsibilities are very great, who may not always judge rightly, but who, I am sure, if they would cordially unite with those who can give them information in this and other institutions, will go forward to great success; while jealousies on all sides can never lead to anything but trial of temper and disappointment.

Admiral of the Fleet Sir GEORGE SARTORIUS: I must commence by expressing my great satisfaction at the able manner in which Mr. Barnaby has treated the subject of his lecture. I must preface the remarks I am about to make by confessing that I know nothing of the science of shipbuilding. I claim only to be the practical sailor whose duty is to navigate and fight the ship. I always look upon the ship as a magnificent tool, manufactured by able, scientific makers, and then delivered over into the hands of the sailor as the skilful workman who is to make the best use of it for the purposes in view. As the manufacturer can never be practically acquainted with the innumerable and varied difficulties the workman is sure to meet and must overcome, the wise manufacturer should, previous to commencing the manufacture of his tool, search out and consult the ablest and most intelligent of the workmen who are to use the tool as to the nature of the work he has to perform, and his wants and requirements for an efficient manner of doing his work. When well informed upon these points, the manufacturer could hardly fail in manufacturing a very efficient tool. I am afraid the reverse of this mode of proceeding has been the case with the greater part, indeed I may say with almost all the new ships that have been constructed since the commencement of the actual transition state of the Navy. They appear to have been constructed upon the caprice and imagination of the constructors alone, beautiful objects of art and science, but very unfit to do the work required from them.

Naval warfare may be divided into three distinct classes. First, warfare on an enemy's coast; secondly, defensive warfare on our own coast; and, thirdly, ocean warfare.

As the first will be carried on generally in joint expedition with troops for such service, it is indispensable that the war vessels should be of moderate draught, very handy, very swift, able to turn very quickly and in very short spaces, and if with sails, to be perfectly manageable under canvas, in case of accidents to screw, from shot or rock. The war ships will have considerable risks to encounter in the unavoidable duties they have to perform, such as engaging batteries, covering the landing or embarkation of troops, chasing of enemy's vessels, and all which demand a very near approach to the shore or battery, and a rapid fire from their guns. The steam vessels would require a large capacity for stowing fuel.

For defensive coast warfare, the same qualities will be required, but with much less capacity for the stowage of fuel and less draught of water. Masts or sails will not be necessary; perhaps peculiar types will be required for "*permanent defence* "*vessels*."

Ocean Warfare. This class embraces equally those fitted for offensive coast warfare. As these vessels must be adapted at a moment's notice to go to any part of the world in pursuit of an enemy's squadron or fleet, they must have great speed and strength, and if with sail, be able to make six or seven knots on a wind with *sail alone*, and if without masts to be able to carry at least three weeks' full steaming, and should have double screws. They must also be good sea boats.

It is needless to say that none of the vessels actually constructed, can fulfil the conditions required from them as efficient for performing their duties in each of the three classes. They (particularly the larger ones) are too long, they make too large a curve on turning, they carry much too little fuel, and under sail are (the most of them) utterly helpless.

Now for the class of vessels I have been so long advocating, viz., the "ram." To speak of those actually constructed, they are, with many other faults, totally deficient in the most important requisite for the ram, viz., that of speed. What can the strongest man do if his enemy can always avoid his blows, and tease him with annoying attacks. Such a vessel may have the charge of a convoy of transports of troops or merchant vessels, and they are met by an enemy, ram or otherwise, but very rapid and handy; she could get in amongst the convoy and destroy half the vessels composing it without giving the slow and heavy protector the chance of getting a shot at the interloper. To use its prow, of course, is out of the question; and could such a ram escape destruction from the attack of two smaller but swifter rams? The efficient ram must have very great speed and great handiness. This is an important fact for us always to bear in mind. There is no nation or combination of nations that will be able to rival us for years to come as ship-builders or engine-makers, therefore there was no necessity for our building in a great hurry so many untried new models. I quite concur with the observations made by Mr. Barnaby at the commencement of the lecture that we ought to study closely, and carefully to obtain the best and most efficient forms and qualities, and not trouble ourselves in accumulating numbers. Should any other nation strike out a more perfect model than any yet produced, we should soon know it, and then construct upon that model, five improved models by the time the originator had completed his one. By keeping a good watch upon what other nations are doing we shall always be able to have a sufficient number of really effective vessels of every good type to prevent any mischief being done at home or to our external empire.

I hope that Mr. Barnaby's excellent example will be followed, and that there will be in future more frequent intercommunications between the manufacturers of the tools and the practical workmen who require them. The result would then be such as to throw great material credit upon both parties, and the country would be benefited.

Mr. BARNABY: I am very much obliged to you for the kind way in which you have received my paper to-night. I was asked to read a paper illustrative of your models, and I only appear here to-night in the character of showman of these models. Some of you have treated me more as if I represented the Lords of the Admiralty; but I do nothing of the kind. Doubtless there are gentlemen here who ought to be Lords of the Admiralty. If they were I think it very likely we should not get orders to build some kinds of ships that have been described to-night. But with that I have nothing to do, and I do not propose to answer any question with regard to them. I would say as to the 9,200 miles which the "Devastation" would run, that this has nothing to do with the formula which has been described. The supposition is that a ton of coals would carry her on an average a certain number of miles. The assumption made is simply that and nothing more. With regard to the "stability" and "cement" question, I might avoid it at this late hour of the evening, and pass on to something else, but I may just say that the loss of the "Captain" caused very great attention to be paid to the "curve of stability." We never had given much attention to it before, and it is that which has mainly led to the introduction of "cement ballast" into ships which were not originally intended to have it. But I have this to say with regard to those ships, that while you could have got the stability by breadth of beam instead of by putting ballast in, there would have been a disadvantage in doing so. The disadvantage is, that as the ship lightens, you lose stability very rapidly if you get stability by breadth of beam, but if you have got it by putting in ballast you do not. A ship will bear being lightened very much better if she has ballast in her than if she has simply got breadth of beam. With regard to these coast defence ships, I call you sailors to witness whether if these models ("Glatton" and "Cyclops") had been put before you three years ago, you would not have said "that's "the very kind of ship we ought to be building," I say we naval architects did but follow, and that you have driven us. With regard to the compound engines, they are being introduced very largely, in fact generally, into the Navy as they ought to be. I am sure Sir George Sartorius will be pleased to know that while there have been no rams proper described to-night, all the armoured vessels have been provided with that powerful instrument.

The CHAIRMAN: I have now only to perform the last part of my duty, which is to thank Mr. Barnaby in your name for the very able paper he has read to us this evening. It is a great satisfaction to all connected with the Institution to find a man in his official position coming here and candidly telling us his story. He has brought before us a vast amount of information which, when printed in our Journal, will form a very compendious and instructive history of what has taken place during the last ten years with regard to the building of our vessels of war. This information we naval officers find a difficulty in getting, and having it presented to us by Mr. Barnaby in this compact form, should make us doubly grateful to him for having brought it before us this evening.

LECTURE.

Friday, February 2nd, 1872.

General SIR EDWARD SABINE, K.C.B., R.A., late President of the Royal Society, in the Chair.

ON THE PRESENT STATE OF OUR KNOWLEDGE RESPECTING THE MAGNETISM OF IRON SHIPS, AND THE TREATMENT OF THEIR COMPASSES.

By Staff-Captain Frederick J. O. Evans, R.N., F.R.S., Hydrographic Department of the Admiralty.

Twenty years have nearly elapsed since an ardent investigator in magnetic science—the late Dr. Scoresby—delivered a lecture in this theatre particularly addressed to the naval profession, and which I had the privilege to hear. In that lecture he expounded certain principles relative to the development of magnetism of a high degree of force, in ships built of iron, during their process of construction;—the special individuality of the distribution of this acquired magnetism depending essentially on the position of the ship's keel and head while building; and also on the subsequent changes which he considered this magnetism must undergo under conditions of mechanical violence or the straining at sea of the ship. Many of his propositions were illustrated by experiments of a simple kind, which, notwithstanding their simplicity, left a lively impression on his audience.

Dr. Scoresby was no alarmist;—but the views he entertained of the instability of an iron ship's magnetism, as affecting her security in navigation, and the danger attending the use of permanent magnets to correct the consequent errors of the mariner's compass; combined with his well-known character as a skilful and bold seaman in youth, philosopher and divine in mature age; influenced the seamen of the period and created much distrust in their minds as to the soundness of certain methods of correction adopted (the result, it may be observed, of a thoroughly scientific investigation), and the consequent security of the ship.

Had Dr. Scoresby been spared to the present time, we may be assured that he would have been gratified in a double sense at the progress of our knowledge of his cherished branch of science; in the first place, because those principles he had so sagaciously elucidated on theoretical considerations from experiments on a very small scale, were confirmed by modern observations embracing ships of a size undreamt of by him, culminating in the "Great Eastern," and armour-clad warships of nearly 7,000 tons. In the second place, he would have been gratified that those principles which he had set forth as to the insecurity attached to the navigation of the iron ship—based chiefly on the reports and opinions of others—were not justified except when the teaching of science had been neglected or evaded.

From official connection with the Admiralty Compass Department, and association with other workers in the field of magnetism, I have been for many years naturally deeply interested in that science in so far as it relates to navigation; a branch of science that I may here observe, affords a wide field for research, and which is by no means exhausted; though much, very much, has been done. It has in consequence fallen to my lot on two previous occasions, namely, in 1859 and 1865, at the invitation of the Council of this Institution, to read papers to the Members on the same subject that formed the life-long study of Dr. Scoresby. The invitation of the Council to address you is again extended to me; my endeavours, therefore, will be to place before you in the short time at my disposal, those leading facts and principles bearing on the magnetic features of iron ships, and the treatment of their compasses, which mark the progress of our knowledge from the days of Scoresby, as also the general conditions of the question at the present time.

I will first, however, give a concise review of the subjects touched on in the papers of 1859 and 1865, as my desire is to avoid, as far as possible, a repetition of what has already been before you, and to be found in the Journals of the Institution.

The Paper of 1859, gave a slight historical sketch of what had been observed in relation to the deviation of the compass on board ship by the old navigators, and of the several methods proposed for the correction of those errors. The experiments and investigations of the Astronomer Royal in 1838-9 on iron vessels, in the then early days of iron shipbuilding, were touched on, as well as the treatment of a ship's deviation table, by Archibald Smith—a name now well known in connection with magnetical science—for finding the five co-efficients A, B, C, D, E, which represent the resolved values of the magnetic disturbance at the particular compass; together with the results of this method of investigation when applied to certain wood and iron-built ships of that period. The magnetical investigations of Dr. Scoresby, and the labours of the Liverpool Compass Committee at that time actively engaged, were further noticed.

The paper of 1865 treated in much detail the magnetism of iron and ironclad ships of war, for in the interval from 1859 great advances had been made, both in the theory and practice incidental to this branch of the navigator's art. The necessity had, as it were, been forced by the unlooked-for introduction of armour plating, gun turrets, shot-proof transverse bulkheads, and such like masses of iron in ships of war, together with the general employment of iron for decks, beams, and other internal fittings of the ordinary ship; and thus the approximate mathematical formulæ in use in 1859, and which sufficed for the moderate compass deviations of the early iron ships, ceased to be applicable.

The necessary extension of the mathematical theory was undertaken by Archibald Smith, and this revision, together with that of the practical methods for ascertaining and applying the deviation, were given in the Admiralty Compass Manual which then (1865) had reached a second edition, and, at the present time (1872), a third.

This manual is in its several parts concisely described in the paper of 1865, together with the practical adaptations of its more important formulæ; and the numerical values of the several parts into which the errors of the compass are divided in their mathematical treatment, whether with the ship upright or heeling, are given for those of the armour-plated ships of war which had been built, equipped, and undergone sea service in the interval from 1859.

The principal conclusions then drawn from the application of observation and theory to the magnetic phenomena in iron ships followed, with general remarks on magnet correction and other details incidental to the subject.

The paper appropriately closed with the substance of a *vivâ voce* explanation by Archibald Smith, on what, before the later investigations referred to in the paper, were the most obscure of the varied magnetic phenomena observed in an iron ship; namely, that part of the deviation which arises from the transient magnetism induced in the soft iron of the ship by the earth's magnetic force, and which is independent of the position occupied by the ship in building.

This *résumé* of an obscure question, illustrated as it is by the action of "three soft iron rods," and which alone appears in this form in the Journal of this Institution, has always appeared to me a model for clearness, accuracy, and conciseness of what, to most minds, would be conflicting and complicated. I regret that on the present occasion my esteemed friend and fellow-labourer cannot be present from the state of his health.

To resume the subject of the present state of our knowledge of the magnetism of iron ships, and its collateral branch, the treatment of an iron ship's compasses.

The most important feature of the first part of my subject as being the foundation of our knowledge, is its mathematical treatment; this must be understood to include the algebraical formulæ together with their arithmetical processes and the several geometrical or graphic constructions so useful to the navigator as well as to the analyst. Time will not permit me to touch on these details; there is, however, little necessity, as the Admiralty Compass Manual will be found a complete storehouse. I propose instead to confine myself mainly to a sketch of the leading practical deductions drawn from the discussion of those observations in iron ships, which have been reduced to their several numerical values by the mathematical appliances referred to.

You will see that I am justified in this procedure by the views taken by the President and Council of the Royal Society so far back as the year 1865, as expressed in the following extract from a communication of that body to the Board of Trade on the expediency of a systematic supervision over the adjustment of the compasses of ships of the mercantile marine:—

They say "The theory of the deviation, its causes and its laws, is now "thoroughly understood and reduced to simple formulæ, leaving the "numerical magnitude of a certain small number of quantities to be "determined by observation for each ship separately; and further by "recording, reducing, and discussing the deviations which have been "observed in the ships of the Royal Navy of different classes; numerical results as to the values of these quantities of ships in each "class have been obtained which promise to be of the greatest use in "facilitating the complete determination of the deviation and its correction . . . .

"The science of magnetism in relation to navigation is in fact in a "position in some degree analogous to that in which the science of "astronomy at one time was. The principles of the science have been "established, the formulæ have been obtained, but numerical values "are wanted, which can only be derived from a large number of observations systematically made and discussed."

Although, as will be seen by the extracts just read, no doubts exist in the minds of those who have patiently investigated and applied the apparently slow enunciations of science in reference to the mathematical treatment of the iron ships' magnetism; still to a comparatively recent date, it had scarcely commanded the confidence of the naval profession. Seamen appeared either to fail in appreciating the true value of a scientific mode of treatment, or perhaps hoped that some short road might be discovered involving no labour or thought to follow out, and, of course, no science to evoke, and thus at once settle the question of the practical and perfect working of the mariners' compass.

I should be wanting in allegiance to scientific truth as opposed to such popular fallacies, were I not here to state my conviction that the general formulæ elaborated by the mathematician to give the navigator security and confidence in his compass, do satisfactorily represent the observed phenomena productive of error, in every class of ship yet come under investigation; and I would further add, that I cannot conceive how the complicated details of an iron ship's magnetic features can be understood, and the numerous sources of error affecting the compass recorded, and, as far as possible, eliminated, without such mode of treatment.

Before passing from these considerations of the theory, permit me to read to you an extract from an article in the *Quarterly Review* for October, 1865, on the Mariners' Compass, written by a distinguished mathematician, who in the interests of literature had mastered the subject. In a few brief sentences you will be told to whom homage is due :—

The writer says : " It would be out of place in these pages (even if " our space allowed it) to enter into any detailed examination of the " extremely elegant mathematical investigation first published by " Mr. Archibald Smith in the " Philosophical Transactions " of 1847, " and to be found in a more mature shape in the last edition of the " Admiralty Manual on Compass Deviation. The briefest possible " account of the general character and broad results of the work and " its relation to earlier investigations, is all that is practicable here. " The first mathematician who attacked the problem of the disturbance " of the compass by external attraction, was the eminent French philosopher, Poisson. After the manner of his country, Poisson treated " the question in its greatest generality, and obtained formulæ giving " the deviation of a needle under the combined influence of any arrangement of magnetized and unmagnetized iron. Beyond this point " the labours of Poisson were of little practical service, and it remained " for others to give a real significance to the arbitrary constants of " his formulæ, by tracing their connection with the actual construction " of a ship, and reducing them to a form which would admit of a direct " application of the theory to practice.

" To the Astronomer Royal belongs the credit of having first dealt " with the investigation of this practical problem, in the year 1839, in " connection with his experiments on the 'Rainbow' and 'Ironsides;' and for a time his papers, printed in the 'Philosophical " Transactions' for 1839, contained the only available theory on the " subject. Although it has since been found necessary to build up the " formulæ for practical use upon a more rigidly accurate basis, it is " impossible to over-estimate the importance of Mr. Airy's first conquest " in what was then an obscure and almost untried field of science. " The novelty of Mr. Archibald Smith's treatment of the subject at a " later epoch, consisted simply in discarding all arbitrary assumptions " whatever, and dealing with the actual problem on the footing of " Poisson's equations, which by a series of elegant transformations he " reduced to forms admitting of immediate practical use, and bearing " their own physical interpretation on their face. Certain happy geometrical constructions, by which the theory is made available for the " seamen without the necessity of referring to the mathematical " formulæ, are not the least valuable and original portions of the " investigations."

In my paper of 1865, you will find noticed the magnetical features of six of our earliest armour-clad war ships, with the numerical values of their co-efficients. Between the year 1865 and the present time, our armour-clad ships have been greatly increased, and several novel types of war-vessels introduced.

Five troop-ships of large dimensions have been added to the ordinary class of iron ships, together with three large cruizers sheathed with wood, and several small iron unarmoured gunboats.

A distinct class of vessel has also come into prominence in the same period; eighteen cruizers of about 450 tons each, constructed on what may be termed a complete "composite system" of wood and iron; and nearly thirty more of much larger tonnage, some reaching 1,500 tons, on a partly "composite" system. The vessels on the complete composite system have their ribs, beams, stringers, and upright supports constructed of iron, and conform in magnetic character in a very marked degree, to the iron built ship; in the partly composite vessels the iron ribs are wanting, and their magnetic character is less distinctly marked.

The custom of the Admiralty Compass Department is to allow no vessel of any of the classes to which I have referred, to proceed in the first instance to sea without their complete magnetic history being known; this includes not only the forming tables of deviations for their several compasses, but also the values of the horizontal and vertical magnetic forces of the ship at the compass stations as compared with the earth's magnetic force. The observations for this history are not unfrequently commenced when the ship is on the stocks.

These observations, together with such as may be subsequently made in the course of the ship's service, are reduced by the appropriate formulæ and the several resulting co-efficients and their constituent parts recorded for future reference.

Appended is a Table containing the magnetic elements of a few ships of various types. It is introduced as illustrative of the method of recording the several co-efficients and their constituent parts;—as also showing the increasing amount of error, especially that arising from the induced forces, the consequence of the increased amount of iron employed in the construction of the modern vessel.

The steam-ship "Rainbow" (in the first column) is the first ship experimented on (1838) to determine the nature of the magnetism of iron vessels and the co-efficients are those resulting from the Astronomer Royal's observations. The merchant ship "Clyde," in the second column, is a fair type of the modern iron ship, and is introduced to compare with the "Rainbow." The remaining examples are types of modern ships of the Royal Navy. In the last column are the co-efficients at a compass near the steering wheel between decks, on the starboard side, in the "Cyclops" turret ship: the co-efficients A and E in their large values are confirmatory of the theoretical principles established for compasses that are placed out of the midship line of the vessel—these co-efficients at compasses in the midship line are usually zero.

Table of Magnetic Elements of various Ships,

		Merchant Ships.	
		Steam-ship. 500 tons.	*Sailing ship. 1,100 tons.*
	Ship's name	" Rainbow."	" Clyde."
	Head built	*to N.N.W.*	*to N.E.*
Observed	Place	Deptford.	Greenhithe.
	Date	1838.	1863.
		° ′	° ′
Approximate Co-efficients of Deviation.	Constant . . . A	+ 0 35	+ 0 41
	Semicircular . . . B	−18 45	− 7 56
	C	−12 57	+ 7 25
	Quadrantal . . . D	+ 2 30	+ 4 43
	E	+ 0 02	+ 0 08
Exact Co-efficients of Deviation.	Constant . . . $\mathfrak{A}$	+ ·010	+ ·012
	Ship's force to head . . . $\mathfrak{B}$	− ·327	− ·143
	Ship's force to starboard . . $\mathfrak{C}$	− ·217	+ ·124
	Induced forces . . . $\mathfrak{D}$	+ ·044	+ ·082
	$\mathfrak{E}$	+ ·001	+ ·002
Maximum semicircular deviation or $\sqrt{B^2 + C^2}$		$22\frac{3}{4}$°	11°
Mean Horizontal force of ship.	Amount . . . $\sqrt{\mathfrak{B}^2 + \mathfrak{C}^2}$	·392	·189
	Direction, or "starboard angle" $\tan^{-1}\frac{-\mathfrak{C}}{\mathfrak{B}}$	213°	139°
(*Mean force to north* (λ*H*) *being unit.*)			
Mean Horizontal force on board to north, or λ (*Earth's horizontal force* = 1·0.)		·972	·870
Fore and aft horizontal induction, or . . . a		+ ·015	− ·059
Transverse ditto or . . . e		− ·071	− ·201
Parts of D	from fore and aft induction	+ 0° 24′	− 1° 57′
	„ transverse „	+ 2 07	+ 6 39
Mean vertical force on board, or . . . μ (*Earth's vertical force* = 1·0.)		—	1·275
Heeling error for 1° of heel of ship (+ *to windward* − *to leeward.*)		—	+ 1° 22′
Heeling Co-efficient	from vertical induction in transverse iron	—	+ 0 35
	from vertical force and induction in vertical iron	—	+ 0 47
Variable part of vertical force, or $\frac{g}{\tan \text{dip}}$		—	—

at selected position of Standard Compass.

Indian Transport. *4,173 tons.* *700 h.-p.*	Modern war ships.			
	Composite build. *4 guns.* *467 tons.*	*Iron gunboat.* *245 tons.*	*3,893 tons.* *14 guns.* *800 h.-p.*	*2,107 tons.* *Turret ship.*
"Serapis."	"Avon."	"Kite."	"Swiftsure."	"Cyclops."
Built North, fitted S.S.W.	*S. 57° E.*	*S. 34° W.*	*Built S.56° W. fitted N.N.E.*	*Lower deck compass.*
Greenhithe.	Portsmouth.	Greenock.	R. Tyne.	Sheerness.
1867.	1868.	1871.	1871.	1871.
° ′	° ′	° ′	° ′	° ′
− 0 56	+ 0 33	+ 1 55	+ 0 38	− *5* *0*
−18 56	+17 04	+33 16	+20 15	−36 09
− 5 24	+20 20	− 18 20	− 9 43	+16 04
+ 4 51	+ 4 01	+ 8 35	+ 7 18	+13 45
− 0 18	+ 0 10	+ 0 05	+ 0 10	− *6* *43*
− ·016	+ ·009	+ ·033	− ·011	− ·087
− ·339	+ ·300	+ ·588	+ ·368	− ·679
− ·089	+ ·333	− ·138	− ·156	+ ·266
+ ·085	+ ·070	+ ·149	+ ·127	+ ·240
− ·005	+ ·003	+ ·001	+ ·003	− ·117
19¾°	26½°	38°	22¼°	40°
·351	·449	·604	·400	·729
194½°	48°	347°	337°	159°
·905	·920	·822	·790	·486
− ·017	− ·016	− ·079	− ·110	− ·398
− ·173	− ·144	− ·277	− ·310	− ·630
− 0° 32′	− 0° 28′	− 2° 46′	− 3° 56′	−24° 05′
+ 5 27	+ 4 29	+ 9 44	+11 14	+40 24
1·170	·819	·705	1·118	*strong upward force.*
+ 0° 57′	− 0° 06′	− 0° 04′	+ 1° 29′	—
+ 0 29	+ 0 23	+ 1 0	+ 1 05	—
+ 0 28	− 0 29	− 1 04	+ 0 24	—
+ ·024	+ ·049	+ ·039	+ ·076	—

On examining these general records to the end of 1871, I find that, excluding our wood-built fleet, we have more or less complete the magnetic history of—

25 Iron armour-clad ships,
14 Wood armour-clad ships,
9 Iron armour-clad turret ships,
3 Unarmoured iron cruizers sheathed with wood,
12 Iron gunboats of small dimensions,
50 Iron ships of ordinary construction, varying in size from "Great Eastern" to vessels of 300 tons,
18 Composite build (complete) cruizers,
28 Composite build (incomplete) cruizers.

For these 159 vessels 1,250 deviation tables have been resolved into their several co-efficients, A, B, C, D, E. 400 of these tables have been accompanied by force observations for the determination of the co-efficient λ *(lambda)*, or the mean horizontal magnetic force of the ship to the north as compared with the earth's horizontal magnetic force, and about 300 determinations of the ship's vertical magnetic force as compared with the earth's vertical force: the latter made in order to obtain the amount of deviation due to those forces, which, when the ship was upright, acted vertically and did not disturb the horizontal compass-needle, but when the ship heels over produce a sensible error, technically known as the "heeling error."*

For some of the armour-clad ships we have 30, 40, 45, and in one ship 53 deviation tables, divided between the standard compass, the steering, and other compasses, including those below decks.

The several discussions of these extended observations, combined with those made in former years by the Liverpool Compass Committee, as resulting from the varied experimental investigations made by Messrs. Towson and Rundell (see the three Reports, 1857—61) lead to certain definite conclusions, the chief of which may be thus summarized as general principles.

1. The magnetism of iron ships is distributed according to precise and well determined laws.

2. That a definite magnetic character is impressed on every iron ship while on the building-slip, which is never afterwards entirely lost.†

3. That in an iron-built ship, and in that part of her within which the navigating or standard compass is generally placed, the polar force is that from the magnetism of the whole body of the ship, and is nearly uniform; and that we cannot escape from the action of that force by any care in the selection of a place for the compass.

---

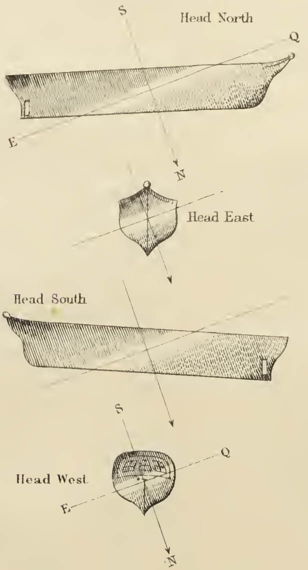
* The observations and reductions in late years have been made by Staff Commander William Mayes, Superintendent of Compasses, and an assistant officer, Navigating Lieutenant Ettrick W. Creak, R.N. Navigating Officers of the Fleet have also contributed observations from abroad.

† See Fig. 1. These theoretical deductions of Scoresby are amply confirmed by experiments made in iron ships of all sizes, built on various azimuths.

Fig 1

Magnetic Polarity of Iron Ships built in Great Britain_Dip 68° to 70° N

(From theoretical deductions by the late Dr Scoresby)



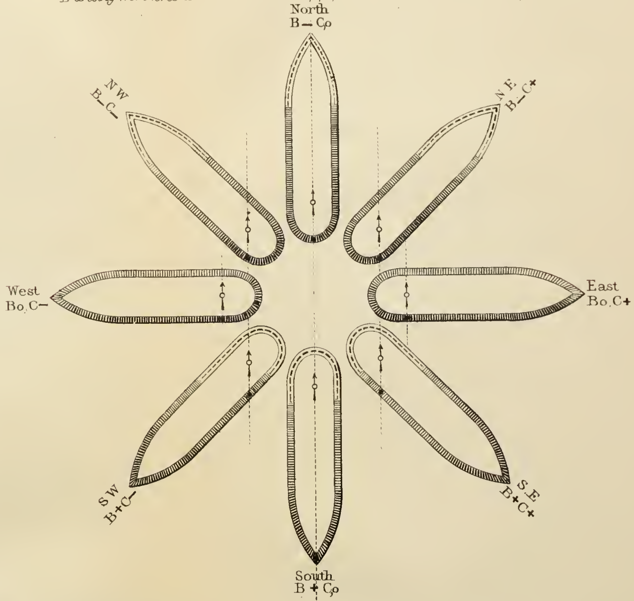
The axial Line SN represents the direction of the dip or line of magnetic force, passing through the general centre of gravity of the material of the ship; the parts of the ship below the Equatorial line E.Q. shaded with broken lines, have North polarity, (or repel the north end of the compass needle); the parts above, shaded with firm lines, have South polarity (or attract the north end of the compass needle.)

Fig 2

Diagrams showing Polarity of the topsides of an Iron Vessel, according to the direction in which her Head may be built with reference to the Magnetic Meridian

(Appended are the signs of the co-efficients of Semicircular deviations)

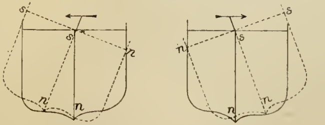
B *arising from force to the head of the ship;* C, *from force to starboard side of ship*



▥ *indicates South polarity (attracting north end of needle)*
╌ *North polarity (repelling north end of needle)*
The intensity of the shading a corresponding intensity of Magnetism

dotted lines through compass needles, line of Earth's force to north.

Fig 3. *To illustrate Heeling error*

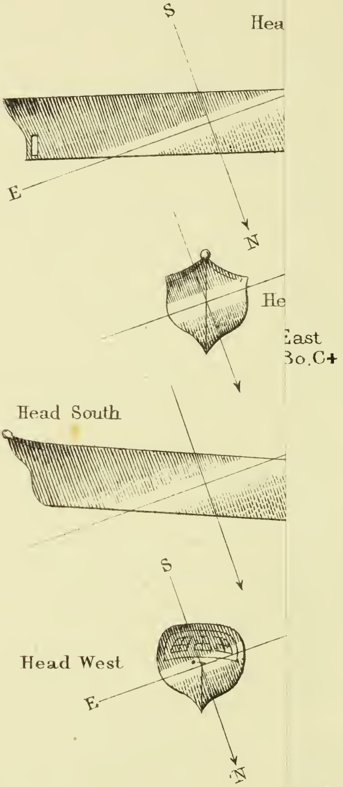


The letters n, s. indicate the polarity of the vertical soft iron, as obtained by induction from the Earth's vertical magnetic force, when the ship heels to starboard or to port.

J. Jobbins

Fig. 1.

Magnetic Polarity of Iron
built in Great Britain_Dip 68°
(From theoretical deductions by the lat



y of Magnetism.

The axial Line S.N. represents the direction of the passing through the general centre of gravity of th parts of the ship below the Equatorial line E.Q. have North polarity, (or repel the north end of parts above, shaded with firm lines, have Sou north end of the compass needle.)

ndicate the polarity
t iron, as obtained
the Earth's vertical
en the ship heels
port.

J. Jobbins

4. That the definite magnetic character of an iron ship, so far as relates to the polar forces developed in her during construction, is shown by the connection which exists between the direction of the ship's original magnetism and the direction of her head when on the building-slip; for the original semi-circular deviation consists principally in an attraction of the north point of the compass-needle to the part of the ship that was south (or nearly so) in building.*

5. That a great reduction takes place in the magnetism of an iron ship on first changing her position after launching, and that her magnetic state is then unstable for a short period. Then, after a few months' service, perhaps within a year for the average of ships, the time probably depending on the nature of the iron employed in the construction, the magnetism of the ship acquires a very stable character.

6. That in iron-built ships, as at present constructed, the ship's polar force is generally so great as to make it necessary to employ magnets to equalize the directive force on different azimuths of the ship's head, even at the most carefully selected position.

The investigation of the numerical values in more extended detail lead to inferences which I will now place before you.

Respecting the Semi-circular Deviation.

Though on general theoretical considerations of the distribution of magnetism in the iron ship's hull, a position for the compass could be selected where large errors might be avoided, still the practical requirements of the seaman and the architect frequently interpose to prevent choice of site; the magnetic action of the diverse interior fittings and equipment of the modern iron steam-ship are also not unfrequently of an amount sufficient sensibly to affect the resultant error as due alone to the hull, although the latter, it must be observed, will always be found to dominate. We find from these considerations that the amount of semi-circular deviation in ships of similar classes at compasses similarly placed are not comparable; in fact, we must consider each ship to have its own pòlar-magnetic constitution. This dissimilarity of constitution does not exist when we examine into the values of their induced forces.

The following table, for example, exhibits the values of the *maximum* semi-circular deviation in several classes of vessels at the standard compass in selected positions:—

In six iron gunboats, of 245 tons each, from ..	19° to 44°
In fifteen composite gunboats, of 465 tons each, from	15° to 25°
In five Indian transports, of 4,200 tons each, from	17° to 29°
In three iron cruizers, wood-sheathed, 2,300 to 4,000 tons each, from	32° to 43°†

---

* See Fig. 2.

† I am disposed to consider that the high values found in these three ships, "Inconstant," "Volage," "Active," arise from the extra hammering involved in sheathing their bottoms with wood preparatory to coppering.

In six armour-plated ships with central batteries,
of 3,800 tons each, from.. .. .. .. 20° to 48°

The general proposition that a great reduction takes place in the magnetism of a ship on first changing her position after launching, but that after a few months' service the magnetism acquires a comparatively stable character, is sustained by evidence extending over many years. It is difficult to assign numerical values to these changes where so much diversity of character exists in the several types and constitutions of ships; but we may assume that in the first month or two after launching, and if in the course of equipment her head has been on different azimuths, about one-fifth of the semi-circular deviation that existed when on the stocks, would be dissipated. This is in accordance with a few cases actually observed. From this time until the period of stability is attained, the residual semi-circular deviation further decreases by about another one-fifth.

In reviewing these changes and those that subsequently arise from the changes of geographic position, we must consider that although the principal part of the semi-circular deviation is caused by permanent, or as we may more properly call it, sub-permanent magnetism: a residual part is independent of the ship's position in building, being the effect of *transient* magnetism induced in the ship by the earth's vertical force. It is the first and largest of these parts that diminishes so much in the early history of the ship, and which subsequently attains its fixed and permanent character, while the smaller residual part probably changes little, if at all, so long as the ship remains in the same magnetic latitude. On change, however, of magnetic latitude, this residual part rapidly changes, and its effect on the north end of the needle is reversed on the ship attaining the southern magnetic hemisphere.

Now if a compass is properly placed with reference to vertical iron by there being a fair distribution of the latter on either side, before or abaft the compass, the changes arising from the sub-permanent and transient magnetism induced by the earth's vertical force would be very small; while if unfavourably placed, such as being near the rudder-head and sternpost, there would assuredly be very large changes on change of magnetic latitude.*

At the standard-compass of many of the ordinary built iron ships in the Royal Navy, it is found that not only is the semi-circular deviation very constant in amount,—showing the stability of the magnetism,—but that on great changes of geographic position it is found to arise from permanent magnetism; a fact rendered obvious from the semi-circular deviation varying at a rate inversely proportional to the value of the earth's horizontal force, and not directly proportional to the value of the tangent of the magnetic dip. In these ships the changes of deviation ensuing on any part of their voyage can be confidently predicted.

---

* There is an existing but fallacious belief that in every iron ship a place can be found where all the "magnetic influences balance," or a *neutral point* where a compass can be placed free from errors of any magnitude. At a recent discussion in the Institution of Naval Architects, this belief was put strongly forward, and it was further stated that such a neutral point existed in H.M. Ships (p. 245 of "Transactions" for 1871). The statement is erroneous, and the belief is only true thus far, that in some few ships a position may be found where, from the magnetism of a particular mass of iron—such as the rudder-head—counteracting that of the ship, the semicircular deviation will be small; yet such positions are in general to be avoided, as the change of magnetic force there will probably be larger and less regular than when the compass is only acted on by the general magnetism of the whole ship. Such positions of insecurity are certainly avoided in H.M. Ships.

As an approximate rule, in the ordinary iron-ship built in England at a well-placed compass, from one-fourth to one-eighth may be taken for the induced part or that affected by changes in the dip, and from three-fourths to seven-eighths of the whole magnetism for the permanent part. The changes of deviation on change of geographic position can thus be approximately predicted.

In the armour-plated ships the amounts of the induced and permanent magnetism appear to be nearly equal, although it is worthy of observation that the changes of semi-circular deviation in their early history are less marked than in the ordinary type of iron-ship, and that its settled value is sooner established; conditions probably arising from the increased amount of hammering in the progress of their construction.

On the Loss of Directive Force in the Compass-needle and the Quadrantal Deviation.

One of the most remarkable features in the iron-ship's magnetism, as arising from the increased use of iron in their structure, is the increasing prejudicial effect on the action of the compass by the mean directive force of the needle being in consequence diminished; by this diminution of force, the effects of all the disturbing forces on board, especially those which may arise from the friction on the needle, due to imperfect workmanship or wear, are increased.

It will be seen by the tabulated coefficients of the several vessels that are appended, that while in the early constructed iron-ship experimented on by Mr. Airy, the mean directive force to the north acting on the needle, or (λ), is ·970, or a loss of only ·030, as compared with the earth's horizontal force considered unity; in a similarly placed compass on board the modern iron merchant-vessel "Clyde," it is ·870, a loss of ·130, or about one-eighth. At the standard-compass of our armour-plated ships, λ is generally not more than four-fifths, and at their main deck compass three-fourths of the earth's force, while within the breast-work of the "Cyclops" class it is reduced to nearly one-half.

As these striking facts do not appear to have been recognised by those projectors who aim at demagnetizing the iron ship, it is desirable, perhaps, here to state that it admits of experimental proof, that this diminution of force is not the effect of permanent magnetism, but alone arises from induction in the "soft" iron of the ships by the earth's horizontal force, and that were it possible to demagnetize or depolarize the ship, this diminution, or the quadrantal deviation which arises from the same cause, would not be affected.*

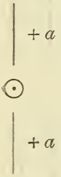
---

* If we place a compass over a circular plate of purely soft iron, no deviation will be

Now the quadrantal deviation (D), which assumes a large value in our modern ships, especially when armour-plated, admits of the same experimental proof that it can alone be caused by *horizontal* induction in *soft* iron, and thus its connection with λ.

Conceive, for example, the following arrangements of soft iron in which the ship's head is supposed to be directed towards the top or bottom of the page.

No. 1.



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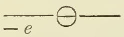

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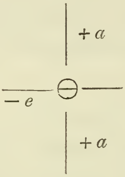

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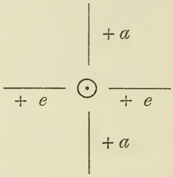
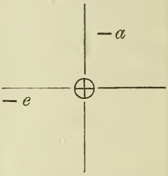


No. 5.



We may consider + *a* to represent masses of soft iron entirely before or abaft the compass, as engines, boilers, funnels, iron masts, &c.

„ − *a* „ soft iron extending through the position of the compass, as the keel and hull of the ship, screw shaft, armour plating, &c.

„ − *e* „ the effect of all the transverse soft iron, as the bottom of the ship, iron decks, iron beams, &c.

„ + *e* „ masses of soft iron which lie to one side of the compass, as guns, davits, or when the compass is in or over a hatchway.

Between these various arrangements there is this important difference, that in Nos. 1 and 4 the directive force of the needle would be increased, while in Nos. 2 and 5 it would be diminished; in No. 3 it might be either increased or diminished, or left unaltered, as the effect of the longitudinal and transverse iron preponderated.

For the deviation, as the ship swings round—

+ *a* will give a *positive* quadrantal deviation.*
− *a* „ *negative* „
− *e* „ *positive* „
+ *e* „ *negative* „

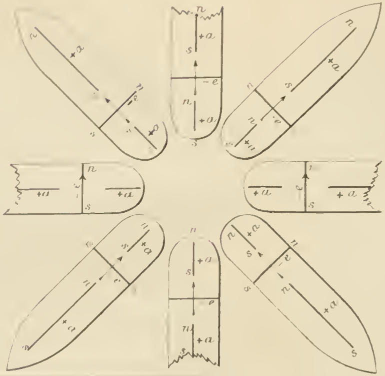
---

produced, but the directive force of the needle (as shown by the slowness of its vibrations, when compared with those made in a place free from disturbing causes) will be diminished, arising from the magnetism induced in the circular plate by the earth's magnetism, acting in a direction antagonistic to that of the earth's force. A similar effect is produced when the compass is enclosed in an iron vessel or a hollow shell; hence we see how a compass placed above an iron deck, and still more between iron decks, loses a great part of its directive force.

* *i.e.*, a deviation of the needle to the east in the 1st and 3rd quadrants, to the west in the 2nd and 4th quadrants. A *negative* quadrantal deviation is the reverse of the foregoing, *i.e.*, west deviation must be substituted for east, and east deviation for west; in both cases + sign representing east deviation, − sign, west deviation.

To illustrate parts of Coefficient D (or the quadrantal deviation) arising from fore and aft and transverse induction in soft iron of Ship

Fig. 4.



Note The letters n s indicate the polarity of the horizontal soft iron as obtained by induction from the Earths horizontal magnetic force in the successive azimuths of the ships head

Fig. 5

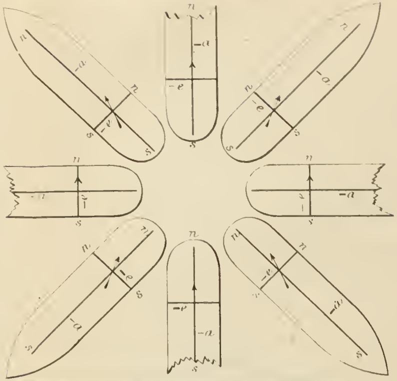
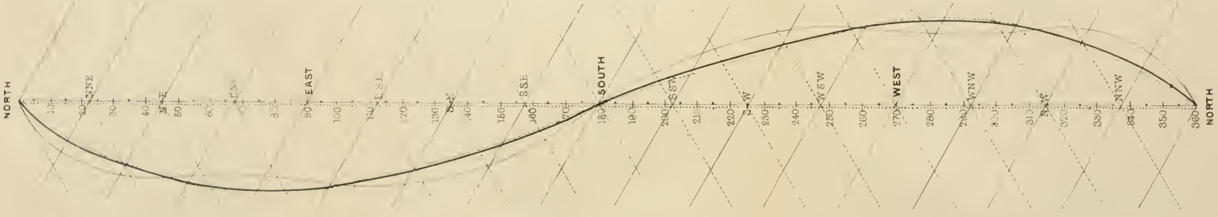


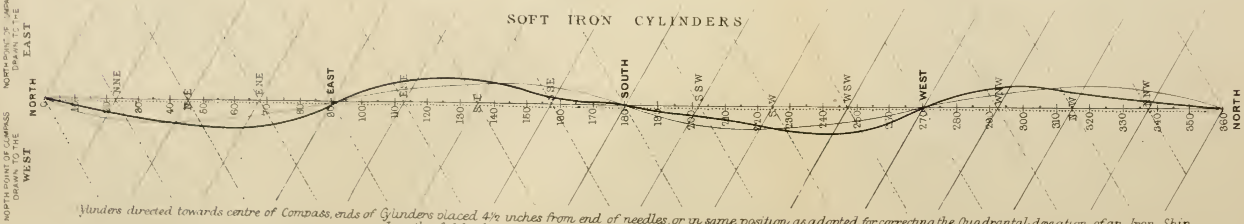
Fig. 6

MAGNET ENDWAYS

Compass needles placed on a fixed pivot in centre of revolving table · So. pole of 12 inch bar magnet 18·25 inches from the pivot, 2·75 inches below its level.
Experiments with single needles - Light continuous curve, 12 inch needle; Black continuous curve 6 inch needle; Light dotted curve 3 inch needle



SOFT IRON CYLINDERS



Cylinders directed towards centre of Compass, ends of Cylinders placed 4½ inches from end of needles, or in same position as adopted for correcting the Quadrantal deviation of an Iron Ship
Length of Cylinders including hemispherical ends 12 inches, diameter 3 Inches.
Light curve, Compound Needles Admiralty Standard Compass card 7.6 inches - Black Curve, Single Bar Needle, 7.5 inches long

J. Jobbins

To illustrate parts of Co-eff

Fig. 4.

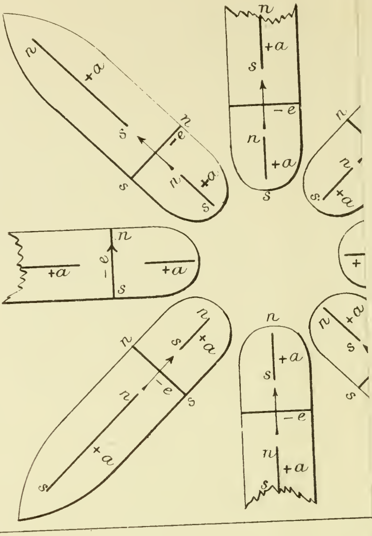
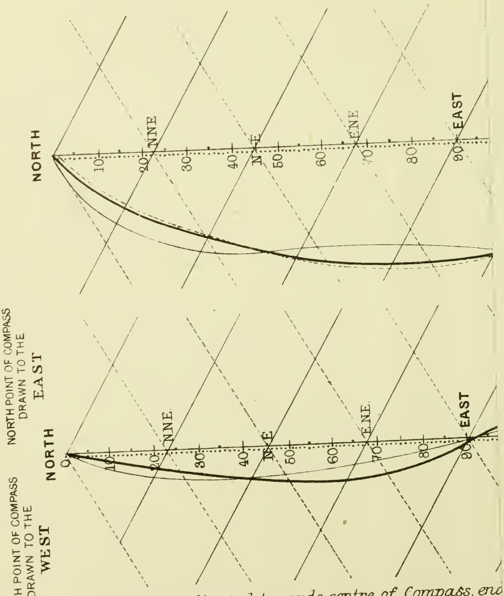


Fig. 6.

Compass needles placed on a
Experiments with single r



Cylinders directed towards centre of Compass, end

Light curve, Co

ins

Applying these principles to the observed facts, it is found, without exception in every iron ship, at the ordinary place of the compass, that the quadrantal deviation is *positive*, or follows the sign + − + − in the successive quadrants NE., SE., SW., NW., from whence we may infer that it is caused by the co-existence of the arrangements of masses of soft iron represented by $+ a$ and $- e$, as shown in Fig. 4, or the excess of $- e$ over $- a$, as shown in Fig. 5.

The investigations of the observed values of D and λ give this result, that the positive value of D arises from the transverse iron continued from side to side, such as beams, decks, bulkheads, and the ship's bottom, producing a large $- e$, and overcoming the force of the fore and aft iron, or a; the latter is sometimes, but rarely +, but more generally −, and when − always less than e (see tabulated co-efficients); and hence that it is caused by the excess of the thrust on the north end of the compass needle from the north *side* of the ship, over the thrust from the north *end* of the ship.

In this explanation of the causes of the quadrantal deviation, I have somewhat gone over the same ground as in my paper of 1865, but the facts given in that paper on the subject appear by more recent proposals and writings in reference to the magnetism of iron ships, to be entirely overlooked; a serious omission, which I now endeavour to rectify by a reiteration of the principles.

At the standard compass of ordinary iron ships the quadrantal deviation is usually from 4½° to 5°, in armour-plated iron ships 6° to 7°. On the main deck of the latter class it rises to 8° and 10°, while in the batteries and between decks of the turret ships it reaches the enormous amount of 15° and 20°.

The diminution of the directive force, and the amount of the quadrantal deviation, are nearly the same at the same level in different parts of the ship. They increase in descending from the position of the standard compass to the steering and main deck compasses, particularly in ships having a thick iron deck. The diminution of the directive force, and the quadrantal deviation, both diminish with the lapse of time, there are also grounds for believing that λ is affected by temperature, diminishing by increased temperature, but this consideration does not affect navigation.

Respecting the Heeling Error.

I now arrive at the question of the "heeling error" in iron ships, or that amount of deviation which is superposed on the ordinary deviation of the compass when the ship heels over to port or to starboard from an upright position, and which, for theoretical and practical purposes is in its value indicated for every degree of heel of the ship.

Theoretically considered, the heeling error is a complicated though not an obscure problem; fortunately practically considered, it does not baffle the careful navigator, nor is it without amelioration by partial correction through the aid of magnets, and especially by a proper position being selected for the compass. In all cases we know that its *maximum* amount occurs when the ship's head is *north or south* by the disturbed compass, and that it vanishes when the ship's head is *east or west* by that compass. So forewarned, the navigator knows when he can ascertain the extreme amount of error from actual observation at sea, and when to use precaution.

The worst possible condition for producing heeling error is when an iron ship is built head north, and the compass placed near the stern,* as that part is strongly magnetised, and all the additional forces developed by the ship's heeling conspire to produce the error. These forces are—

1. Vertical induction in transverse iron, such as the beams, &c.

2. The vertical force from the permanent magnetism of the ship.

3. The vertical induction in all vertical iron situated under the compass, such as the sternpost, stanchions, &c., and each force pulls the north end of the needle downwards and to windward.†

Conversely, the best possible condition for the reduction of the heeling error is in the ship built head south (or from SW. to SE.), when the compass is placed in the after part of the ship; as then force 2, from the reversed polarity of the stern of the ship, operates against forces 1 and 3, and may exceed them in intensity;—if so, a small heeling error to leeward would result. Hence the difference in the heeling errors of individual ships: it is, applying a term I did when speaking of the semicircular deviation, a constitutional error, and one ship affords no guide to another unless all the conditions of build are the same.

The numerical values of the heeling error in the ships of the Royal Navy are about as follows:—At the standard compass of the armour-plated ships, when in England, the worst type does not exceed $1\frac{3}{4}°$ for each degree of heel, and it is always to windward; 1° and under would, perhaps, be the average: in all these ships about $\frac{3}{4}°$ is found to arise from force 1, or that from vertical induction in transverse iron, the remainder from forces 2 and 3. On the main decks of these ships there is a strong upward force producing a heeling error to leeward.

In ordinary iron ships in England the heeling error from transverse iron averages about $\frac{1}{2}°$ to windward, an error it must be remembered which changes with the changes of magnetic dip, and would, therefore, in the southern hemisphere be an error to leeward. The forces 2 and 3 are mixed together in such an uncertain way, depending on the build of the ship and arrangements of iron, that their proportions cannot be estimated.

Fortunately, by a simple class of observations with a dipping needle, and with the knowledge of the co-efficients D and λ, we can approximate very closely to the error that would be found if the ship were actually heeled, and thus a formidable amount of labour is avoided. The details are fully described in the manuals* on the subject.

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* See paper on the loss of the iron ship "Glenorchy." "Royal Society's Proceedings," 1869.

† See Fig. 3 in illustration, when (1) the weather or upper end of the beams and all transverse iron acquire south polarity (s) by induction from the earth (in northern magnetic latitudes); and similarly from induction in vertical iron (3) the south poles are brought nearer the north end of the needle as the ship heels over.

When it is considered necessary to correct the heeling error, the practice in the Royal Navy is to employ a magnet a few inches long, which is inserted vertically in the supporting pillar of the standard compass, exactly beneath the centre of the compass needle, a hole being accurately bored for the purpose.

The simple class of observations for finding the heeling error, without heeling the ship; together with those when a horizontal needle is employed to determine the co-efficients B and C, and thus to form a table of deviations, without swinging the ship, are, from my point of view, among the real triumphs in this branch of science. The time and labour that by these means are saved in acquiring a competent knowledge of the ship's magnetic characteristics are important considerations, with the advantages that a secure and desirable position for the compass may be selected while the ship is even on the stocks, and certainly objectionable positions be avoided.

The degree of approximation to correct results in these methods just brought to your notice, depends on the approach to accuracy with which the values of D and λ are assumed, if they are not known. From the numerous records we have now of so many types of ships, it is not difficult to estimate a value for any individual ship, even when new. As a consequence, nearly all the preliminary work of our ships in the Royal Navy is thus effected, nothing is left to chance even when the architect will scarcely give space and place for selection. With the coefficients determined, the correcting magnets are prepared and placed in accordance, and the ship is ready for the thorough "swinging" to form a table of residual errors—errors which are generally small in amount and not embarrassing to the navigator.

It is well to record here that the results obtained by these several methods, approximate closely to those determined by the complete processes of swinging and heeling, and are confidently adopted by the Admiralty Compass Department.

Notes on the Mechanical Correction of Compass Deviation.

After the investigation of the several characteristics of an iron ship's magnetism, the most important consideration is by what means can we correct or reduce the errors so produced on the action of the mariners' compass?

The now universally adopted method of mechanically correcting the deviations of the compass, was proposed by the Astronomer Royal more than 30 years ago, after a series of remarkable experiments and investigations on two of the earliest built iron merchant vessels; and consists, as is well known, in correcting the semicircular deviation produced by the ship's polar magnetic force, by the application of permanent magnet-bars; and in correcting the quadrantal deviation arising from the induction in the soft iron of the ship by the earth's horizontal magnetism, by the application of soft iron in masses of diverse shapes.

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* See "Admiralty Compass Manual," 3rd edition, pp. 82—89; and "Elementary Manual," companion to the foregoing, pp. 89—104.

In past years, as you will have gathered from my opening remarks on the labours of Scoresby, much diversity of opinion prevailed as to the necessity for, and the freedom from danger in the employment of, permanent magnets; the limits of these diverse opinions are now, from circumstances which I will hereafter explain, very much narrowed. Still among, it is to be hoped, a limited few, erroneous opinions exist on this subject, errors too of a nature that can be disproved by simple experiment.*

The general question of the mechanical correction of the deviation of the compass has, on other grounds, materially changed its aspect of late years; the cause arises from the vast increase in the employment of iron in the interior as well as the exterior fabric of the iron ship.

Ships of the mercantile marine, no less than ships-of-war, have been affected by these changes in naval architecture. Before this period of change the deviation of a standard compass, properly placed in an iron ship, seldom exceeded 20° at the maximum, and the directive force which acted on it as the ship was swung, was comprised within two-thirds and four-thirds of the mean force. In the present day it is generally impossible to find a position for this compass at which the deviation and variations of directive force do not greatly exceed these limits. Hence this change in the conditions experienced has produced a corresponding change in the practice of the Royal Navy. Magnet correction is absolutely necessary in nearly every ship-of-war afloat; and broadly I may here state that the results of the system adopted, a system suited to the magnetic knowledge of the day, are satisfactory both as to efficacy and security.

The process recommended by the Astronomer Royal for the mercantile marine and generally adopted, was, as is well known, a tentative one, or an operation simply "to the making the compasses act correctly:" it took no account of the amount or distribution of the magnetic forces at the position of the compass, due to the hull of the ship, or the disturbing action of individual masses of iron masking the magnetic force of the hull of the ship. But a second method was described by Mr. Airy, in his well-known paper on the magnetism of iron-built ships (Phil. Trans. 1839, p. 196), which did require the knowledge of these important details, and it is this method which is generally employed in the Royal Navy. It may be thus explained.

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* It has been stated, for example, within the last five years in this theatre, by one naval authority, that the employment of correcting magnets decreases the directive force of the needle, and that "common sense dictated at once the sweeping them away;" by another, that they lessen the tendency of the seaman's "guide, philosopher, and friend" (an euphuism for the compass needle) to point truly. These misconceptions will doubtless pass away with the spread of sound knowledge, for in fact, magnets cannot affect the mean directive force, while soft iron correctors increase it.

The co-efficients B, C, λ being found by observation, or when necessary, B and C being found by observation and λ estimated; we have $\sqrt{B^2+C^2}$ the tangent of the semicircular deviation when the polar force acts to the east or west of the compass, and $\frac{C}{B}$ the tangent of the starboard angle. If we desire to correct the semicircular deviation completely, a magnet of suitable size, adequate power, and proved permanence, is selected. The distance above or below the card at which this magnet, when placed east and west, will produce on shore a deviation of which the tangent is $\lambda \sqrt{B^2 + C^2}$ is ascertained by trial. The magnet is then inserted into the pedestal of the standard compass at the ascertained distance immediately below the centre of the card, and in the direction of the starboard angle, the pole being so placed as to counteract the polar magnetism of the ship. In newly built ships, the polar force, as before mentioned, is generally undergoing a process of gradual diminution, it is therefore generally considered best not to correct entirely the semicircular deviation, but to under correct it.

In general, no attempt is made to correct the quandrantal deviation, that deviation and the residual semicircular deviation being the subject of the tabular correction;—a correction it may be observed now thoroughly grafted in the practice of the Royal Navy, and which practice is certainly productive of security, as its foundation implies that the compass needle must never be considered to point correctly, whatever mechanical correction may be employed.

The question of quadrantal correction by soft iron is a difficult one; it is true that by its neglect a small amount of directive force is lost, and a further small correction of heeling error; the danger, however, that may arise from the large masses of iron necessary for the correction of modern ships taking up polar or permanent magnetism, must be placed as a set off, as also the further consideration that after the correction is effected, all record is lost of the ship's magnetic state.

When the quadrantal deviation is small, as in the ordinary iron ship, it may be, I consider, safely allowed as a residual error; and the omission in practice has this advantage, that it acts as a valuable check on the correctness of the deviation tables constructed by the navigator from the circumstance of the coefficient D remaining constant, or nearly so, under all changes of time and place.

With the large quadrantal deviations at the between-deck compasses of our armour-plated ships, two compasses brought together sufficiently close to produce a *negative* quadrantal deviation equal in amount to the *positive* value of the ship, and then mutually corrected by one system of magnets for semicircular deviation, have proved useful, but the loss of directive power at the place is not remedied. This is a subject now engaging the attention of the Compass Department.

It may be here naturally asked why the practice of compass-correction, which is now considered efficacious and secure, should in the earlier period of the iron ship's history, have been deemed untrustworthy and indeed dangerous? The reply is not difficult; the magnetic conditions of the few iron ships of the Royal Navy at that period did not as a matter of necessity, require magnet correction—their compass deviations rarely, if ever, exceeded 20°—tabular corrections were readily obtained, and gave ample security. The practice of compass correction was thus confined to the mercantile marine; the process, as recommended by the Astronomer Royal and generally adopted, being purely a tentative one, was easily carried out in practice and involved little or no knowledge of principles: it soon became a branch of ordinary trade business in connection with compass manufacture, and the professional "compass adjuster" has been long established at all our chief mercantile ports.*

Unfortunately, too, the practice of furnishing the seamen with a table of residual errors was not at the same time adopted or its necessity recognized, but on the faith of the professional adjuster, the compass was considered correct.

It was further a prevailing custom at this time in the mercantile marine to use the steering or binnacle compass alone for the navigation of the ship. This compass was usually not more than two feet above the deck beams, and frequently placed in the after part of the vessel near such vertical masses as the stern-post and rudder. Large and irregular deviations were sure to obtain at this position, the large errors requiring to be corrected by large and powerful magnets; the result was that the slightest change in the magnetism of the ship produced a large compass error, and not unfrequently in foreign-going ships proceeding to the southern hemisphere, on reaching the latitude of the Cape of Good Hope, the compass was entirely useless: this arose from the induced magnetism of the rudder and other adjoining masses then acting in unison with those correcting magnets, which originally at the port of departure had been purposely placed to act in direct antagonism.

This indiscriminate use or rather abuse of the method of correction by magnets, was certainly not intended or contemplated by the Astronomer Royal when he freely gave seamen the issue of his valuable labours; but the prejudices arising from the numerous recorded failures, the result of an ignorant application of a sound scientific principle, operated for many years against a proper spirit of enquiry into the causes of failure.

In 1855, however, the Liverpool Compass Committee,† under the auspices of the Board of Trade and with a large number of iron ships of the mercantile marine of that port placed at their disposal, commenced a vigorous inquiry into the general question of their magnetism, and the correction of their compasses; in their Third Report, embracing the period 1857—1860, and dated February, 1861,* they state with reference to the latter—

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* I am here nearly quoting the words of Mr. Rundell, many years Secretary to the Liverpool Compass Committee, and perhaps the best authority on this point in the country. In a paper read before the Institution of Naval Architects in 1866, "On Compass Equipment in Iron Ships, and Government Supervision," he remarks:—
"Experience shows that compass adjusters rarely know more than the mechanical
"practice of adjustment, as explained by the Astronomer Royal more than twenty-
"six years since—a practice so simple that any person of ordinary ability could,
"under good instructions, acquire it in a few hours."

† The formation of this Committee originated from the discussions that took place at the meeting of the British Association for the Advancement of Science, held at Liverpool, in 1854, on a paper by Dr. Scoresby, "On the Loss of the ,Tayleur,' and the Changes in the Compasses in Iron Ships."

"The compass errors occasioned by the more permanent part of a "ship's magnetism may be successfully compensated, and that this "compensation equalises the directive power of the compass needle "on the several courses on which a ship may be placed."

It will of course be understood that this general statement, is subject to the qualification, that magnet correction in a newly-built iron ship must not be strictly depended on, that we ought not to disregard the magnitude of the original deviation, as also that when the correction is applied to compasses having large deviations and placed near large vertical masses of iron, as a rudder, there must always be great uncertainty as to the correction on a change of magnetic latitude.

About the same time that the Liverpool Compass Committee were engaged on their Third Report, I was engaged in the reduction and discussion of the deviations observed on board all the iron-built ships of the Royal Navy, numbering among them about fifteen vessels of ordinary types that had been employed on distant stations over several years.

In a report I made to the Admiralty on this discussion, the following passage will be found: "On examination of the Tables, it is at once "observed that in the majority of examples therein given, a permanency "of magnetism exists so little affected by changes of geographical posi-"tion as materially to confirm the views entertained by the Astrono-"mer Royal in his earliest discussion (1838), that the effect of "transient induced magnetism in iron-built ships is very small com-"paratively."†

These results were opposed to the then generally received opinion, that the magnetism of an iron ship arose chiefly from transient induction; this opinion being chiefly formed on the reports of the action of compasses frequently improperly placed and corrected by those unacquainted with the principles: they were nevertheless conclusive as to the security of magnet correction for a compass placed with due care, were in unison with the experiences of the Liverpool Compass Committee, and gave confidence when the changes in naval architecture necessitated its employment.

The introduction of magnet correction for the Royal Navy, you will have now gathered was not made until the necessity arose, and a thorough investigation of the causes of past failures and past successes in its application had cleared away the doubts that prevailed: and I may here venture the opinion that had magnet correction been as indiscriminately applied in the Royal Navy as it had been in the mercantile marine prior to these investigations, we should not have had those ample records of the real magnetic history of individual ships, the discussion of which has so greatly conduced to clearing away the obscurity which hung over the subject.

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* In my former papers I have borne testimony to the valuable Reports of the Committee; indeed, without a careful study of these Reports, no one could presume to pronounce authoritatively on the subjects therein reviewed.

† Printed in the "Philosophical Transactions of the Royal Society," 1860, page 346.

Observations on the Treatment of an Iron Ship's Compasses.

In examining the numerous patent specifications relating to the mariner's compass, and which extend back to the year 1776, one is struck with the few real advantages that have been gained by the labours of inventors in this field.

The earlier patents relate chiefly to arrangements and contrivances for making observations at sea of the variation, and for modifying the motion of the ship. In 1813 the liquid compass, a real gain to the seaman, appears to have been first introduced.* In 1818 we have the first patent of an invention "to guard" or "protect" the compass needle from all action arising from iron in its neighbourhood. From about this date the patents increase in number, and of late years, notably since 1850, have somewhat rapidly multiplied.

The designs of the inventors may be thus generally classed:—

a. Mechanical arrangements applied to compass bowl or its binnacle to prevent vibration of the end, or friction on the pivot.

b. An arrangement of metals, or some presumed non-conducting substance, surrounding the compass, to prevent or cut off local attraction.

c. Self acting apparatus for registering the ship's course by compass.

d. Arrangements of auxiliary needles to detect or register the deviation.

e. Arrangements of magnets outside the compass to isolate the needle or prevent action of neighbouring iron.

f. Arrangements of magnets on the compass card to cause it to point at all times to the true north.

g. Special arrangements of cards for visibility at elevated positions, and for adjustments to meet the deviation caused by the ship's iron.

h. Methods for depolarizing or demagnetizing the iron ship's hull, in order to prevent the deviation of the compass.

i. Methods for polarizing such parts of the iron ship as may be deemed requisite to correct or prevent the deviation of the compass.

With the exception of a limited number of the more simple arrangements necessary to the mariner's compass, scarcely one of these numerous inventions are to be seen employed at the present time. The mechanical contrivances for registering the ship's course, for example, are generally remarkable for ingenuity, but fail from this cause for every day use; they give, as a rule, work for the needle to do which detracts from its directive power and consequent accuracy, at a time when these conditions are most required.

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* This description of compass has been improved in later years by many well known makers, and is a necessary part of every ship's equipment.

A number of those patents relating to the "prevention or cutting off "the local attraction" have evidently emanated from minds unacquainted with the rudimentary principles of magnetism; the projectors especially overlooking the fundamental law, that the interposition of a body between the magnet and the needle on which it acts, can as little intercept the action of the magnet as the interposition of a body between the earth and another body would intercept the action of the gravitation of the earth, and also further overlooking a very obvious consideration, that if any body could intercept the action of the ship's iron it would also intercept the action of the earth's magnetic force on the needle.

In other cases, where intelligence has been displayed, the inventor has overlooked, or tried to evade—and believed he had done so—some simple but obvious law, the neglect of which produced failure.

Passing from patented inventions to the adaptations suggested by progress in scientific research, we find embodied in the Admiralty Standard-Compass many sound and elegant improvements over the compasses of olden times. In this instrument, which resulted from the labours of a Committee of well known names in magnetic science, working at the request of the Admiralty between the years 1837 and 1842; we find the application of pure copper of substantial thickness for the bowl, as being the metal next to silver known as the best conductor of electricity for quieting the vibrations of the magnetic needle—an application mainly due to the late Snow Harris. We further find the needles constructed of such a kind of steel, and on such a system as will afford the greatest directive power with little weight, a system the product of the researches of Kater, Christie, and Scoresby. Again, the pivots and caps—an all-important detail of the compass—are constructed of such materials and in such forms as had stood the best test in an extended series of experiments made by the late Captain E. Johnson, my predecessor in office, and a member of the Admiralty Compass committee; and, lastly, a remarkable arrangement, whether considered mechanically or magnetically, is to be found in the disposition of the needles on the compass card.

This arrangement and its bearings I will briefly describe. By the substitution of two or more parallel bars or needles of the compound structure adopted in the Admiralty Standard-Compass, instead of the single bar needle which was formerly in universal use, a much greater directive power was found to be obtained with the same weight. A problem then to be solved was the relative distances of the parallel bars on the card, in order that the "moments of inertia" about all horizontal axes should be equal, for if this condition was not secured, the oscillations of the card would be accompanied with a "wabbling" motion detrimental to good work.

The investigations of Archibald Smith resulted in this law, that two equal parallel bars of which the ends are 60°, or four bars of which the ends are 30° apart—*i.e.*, 15° and 45° on each side of the diameter—secured the required conditions, and this arrangement was adopted, and for many years retained, on account of this property.

But a remarkable, and at the time unlooked for property attended this arrangement of the needles on a compass card. In later years, when the employment of very long needles was getting into fashion, it had been observed that compasses in merchant ships, corrected by magnets and soft iron on the plan of the Astronomer Royal, were affected by anomalous errors; in one case, for example, which came under my own observation, these errors amounted to 5° and 6° on some points of the ship's head. To test whether these errors were caused by the length of the needle and the proximity of the correctors, a series of experiments on the deviation produced on single-bar needles of different lengths by magnets and soft iron were made at the Admiralty Compass observatory. The following results were obtained:—*

With 3-inch single needles deflected by magnets the deviations were nearly semicircular,† but with 6-inch needles, and much more strongly with 12-inch needles, a "sextantal" error of considerable magnitude was introduced.

With soft iron correctors, deflecting a long single needle, in addition to the "quadrantal" deviation, a considerable "octantal" error was introduced.

When the same experiments were made with an Admiralty card, constructed as usual with four parallel needles, the extremities of which are 15° and 45° on each side of the extremities of the diameter to which they are parallel, there was no appreciable sextantal or octantal deviation. On Mr. Smith further investigating this subject on a mathematical basis, it appeared that this arrangement of needles, as well as the simpler arrangement of two needles each 30° on each side of the diameter, produces a complete compensation and correction of these errors.

We see here the remarkable property adverted to, that the arrangement of needles which produces the equality in the moments of inertia, is by a happy coincidence, the same as that which prevents the sextantal deviation in the case of correcting magnets, and the octantal deviation in the case of soft iron correctors.

The practical result is this, that by the employment of Admiralty standard compass cards, or of cards with two needles, each 30° from the central line, correcting magnets and soft iron correctors may be placed much nearer the compass than can be safely done with a single needle card, and that the large deviations existing in iron ships may be thus far more acurately corrected.‡

Before passing from the subject of compass-needles, I would wish to offer an opinion on the employment of those large compasses fitted with needles of extraordinary length, which would appear from modern practice to be considered suitable to ships of extraordinary size. I am aware that these large compasses commend themselves from the facility afforded of steering a course to degrees, instead of the old-fashioned quarter or half-quarter points; and for a certain steadiness due in one sense to the extreme slowness of oscillation in long needles as compared with short ones. There are notwithstanding fallacies and insecurity attending their use, which appear to me borne out by the facts that have come within my own knowledge of fine and well-equipped steam-ships, navigated apparently with precision and care—the course being ostentatiously steered to degrees—and still running ashore in the finest weather in some unlooked-for manner.

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* See Fig. 6, where the several curves are shown on Napier's diagram.

† *i.e.*, followed a curve of sines.

‡ To those who may be interested in this branch of the subject, I would refer to the "Philosophical Transactions" for 1861, where will be found described the whole of the experiments, together with the mathematical investigations. I believe, as resulting from this communication to the Royal Society, that the employment of double needle cards, arranged as described, is now in nearly general use.

Now, it is well known that small magnet bars are proportionally much more powerful than large magnet bars, and that beyond a certain limit, an increase in the length of the magnet bar is not accompanied by an increase of directive power in the same proportion; so that if the thickness of the bar be preserved, its weight and consequently, its friction when supported as a compass needle is on the pivot, increases in a greater ratio than the directive power, and a direct loss of force results.

Common experience embodying this principle, has heretofore limited compass needles for use afloat to about 6 inches (the Admiralty Compass Committee adopted about 7¼ inches as the maximum length), and we may well consider that when these lengths are doubled the increased weight of the card and appendages produce an amount of friction that far exceeds the increase of directive force derived from the added length of magnet bar; the friction further is operated on at a disadvantage from the sluggishness of movement incidental to the long needle.

As a matter of opinion, I consider that the Admiralty Standard Card is as large as should be used for the purposes of navigation, as distinguished from a steering or auxiliary compass; and that as regards safety, in the long, steady, and fast ship of modern days, the choice is really between the Admiralty card and a smaller one.

Briefly to review the question of the mariners' compass. For employment in an iron ship, the chief points to be aimed at are, great directive power and susceptibility of motion; directive power in a high degree to meet the prejudicial effect caused by the earth's horizontal magnetic force acting on the soft iron of the ship, and thus seriously diminishing the mean directive force of the needle, and susceptibility of motion to overcome any tendency of the hanging up of the needle from undue friction or wear in the pivot and cap.

A compass with these attributes is invaluable to the fast ship with little motion in smooth water—conditions, be it remembered, where errors in reckoning have often proved most serious—but such a compass would probably, from its sensibility, fail when in a heavy seaway, or when subject to the violent oscillations of some of our recent ships of war propelled at high rates of speed. I certainly know of no compass that is equally accurate and effective under these diverse conditions;

and that instrument which shall be at the same time accurate and sensitively alive in smooth water, perfect in its action when pitching or rolling to the gale of wind, capable of resisting the concussion from the firing of heavy guns, and not responding to the vibrations produced by an abnormal rate of propulsion by steam, has yet, despite the long list of patents, to be invented. I may, however, I think, venture to assert that, for a combination of all that is effective under the greatest number of conditions, no compass yet projected equals the Admiralty Standard Compass. Its patient designers, with one exception,* have passed away from us, and their labours are but little known: it fell to my lot for some years in my official capacity, to be the conservator of their admirable work when exposed to the adverse influences of rash inventors and economical arguments. I am, however, now gratified to think that lengthened experience has confirmed its merits, and that, intact as I received the Admiralty Standard Compass, so will it remain for our successors, unless, indeed, some master-mind appears to give it those attributes which eager, but, I think, unreflecting minds consider it ought to possess.

I have now passed in review the chief points connected with my subject, which appeared to me to deserve your attention; there is, however, an incident that may be considered to claim attention, from the circumstance that it created much discussion in this Institution. I allude to the "de-polarizing" or "de-magnetizing" process of the late Mr. Evan Hopkins, for rendering correcting magnets or deviation tables unnecessary, by destroying the polarity acquired while the ship is building; and which was applied to Her Majesty's ship "Northumberland." As I have already, in a paper read before the Royal Society, and published in their Transactions,† given my opinions on this proposal and the numerical data on which those adverse opinions are based, I should not, as an incident of progress in magnetic science applied to navigation, have alluded to it here; but, as the proposal has been recently revived with a vigour of announcement and assertion of practical utility scarcely surpassed by the clever but sanguine original projector, I will detain you a few moments by reading brief extracts from the paper to which allusion has been made bearing on the failure of this unsound proposal, as also the condemnatory opinions expressed thereon.

I state, as proved by observations made in ample detail, of the kind I have brought to your notice, and very thoroughly discussed numerically and graphically, "that the process"—(which, departing from the terms of the patent specifications resolved itself ultimately into rubbing the beams and iron stanchions near the compasses with powerful electro-magnets),—"is not one of general de-magnetization, "but of partial counter-magnetization, and results in an irregular dis-"tribution of magnetism of very variable intensity, necessarily very

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* General Sir Edward Sabine, K.C.B., late President of the Royal Society, and Chairman of the present meeting.

† For 1868, pages 487–508.

" unstable, and producing, wherever effective, a rapidly varying field
" of force.

" That so far from the process being in any sense of the word one of
" 'depolarization,' either of the whole ship or any part of it, it was, on
" the contrary, the 'polarization' to a high degree of intensity of a
" particular portion of the iron in the neighbourhood of three of the
" compasses." That " the iron so magnetized was iron capable of re-
" ceiving only sub-permanent magnetism, and which, from its forming
" part of the structure of the vessel, was subject to strains and concus-
" sions from which detached magnets are wholly free. The magnetism
" so communicated was, therefore, necessarily unstable and transient,
" and, from its liability to change suddenly and unexpectedly, was a
" source of danger to the vessel.

" Nor would the effect produced, even if it had been much more
" permanent than it proved to be, be considered an advantage. In two
" out of the three compasses to which it was applied . . . the re-
" quisite reduction might have been effected with infinitely greater ease
" and certainty, as well as permanency, by the application of a single
" magnet to each compass."

Let us, however, in conclusion, pass from the consideration of matters unpractical and unsound to those based on secure foundations. On a review of what in this lecture I have brought under your notice—I fear in a somewhat fragmentary and imperfect manner—the question may be asked, how far has this knowledge extended, and how far has it aided the navigator? The reply, so far as I am aware, is generally satisfactory. Foreign nations interested in maritime affairs have unhesitatingly adopted the principles and the practice of the Royal Navy; their handbooks are all based on our own Admiralty Compass Manual. America, with her iron monitor fleet, having felt the necessity of establishing a Compass Committee of Inquiry some few years back, her Bureau of Navigation at Washington has collected in two volumes, in the interests of the " naval service, and, indeed, of all intelligent navigators," the various theoretical and practical investigations embodied in papers contributed by our countrymen to various learned societies from the time of Poisson's Memoir, to 1866. The preface to the first of these volumes states that " the English investiga-
" tions on compass deviation, while eminently practical, have steadily
" advanced towards establishing a comprehensive and available theory
" in all that relates to this subject."

In our own mercantile marine an impetus to extended knowledge has been lately given by the Board of Trade. Masters, in order to obtain an extra certificate of competency, must pass an examination in our subject—the opportunity has been afforded me of inspecting the examination papers of a few successful candidates, and I found them stamped by a sound practical knowledge of principles and details—highly favourable to a more perfect system of "compass-adjustment" in our merchant ships of the future. The ordinary examination of masters and mates also with the present year embraces the methods of ascertaining and applying the deviation of the compass, the knowledge of which is equally necessary with the calculation of a day's work.

In the Royal Navy, though magnetism as a branch of nautical education has scarcely yet taken root, we have a few Officers well trained in its principles and practice as applied to navigation. This small band of experts, it is to be hoped, will be steadily kept up in the interests of the service. The fact is also assuring, and speaks well for the care and skill of our navigating Officers, that within the last twenty years, so far as I am informed, no misadventure has happened to a British ship-of-war through default of her compasses.

In the interests of navigation—and I say this with pleasure in the presence of one of our greatest masters in magnetic science, and to whom the Royal Navy and myself personally owe many debts of gratitude, I allude to our eminent Chairman—I confidently look forward at no distant date to magnetism in its several divisions occupying a fair share of the attention of naval Officers, not only as a necessary branch of education, but as an intellectual study that carries with it an indescribable charm, and is of a high order for estimating and grasping the more secret workings of nature.

Evening Meeting.

Monday, February 5th, 1872.

General Sir WILLIAM J. CODRINGTON, G.C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between the 30th January and the 5th February, 1872.

LIFE.

Warre, Rev. Edward, Captain, 8th Bucks Rifle Volunteers.
Spratt, Fredk. T. N., Lieut., R.E.
Moreton, Augs. H. M., Captain, Coldstream Guards.
Charteris, Hon. Alfred W., Lieut., Coldstream Guards.

ANNUAL.

Bailey, Vincent, Captain, Herts Militia.
Thorold, Cecil, Captain, 1st Life Guards.
Murray, C. A. Scott, Lieut., 1st Life Guards.
Gillett, W., Captain, Uxbridge Yeomanry Cavalry.
Clayton, W. L. Nicholl, Captain, Isle of Wight Artillery Militia.
Sulivan, G. L., Captain, R.N.
Rossmore, H. C. W., Lord, Lieut., 1st Life Guards.
Cavenagh, Orfeur, Major-General, Bengal Staff Corps.
Cavenagh, Gordon, Colonel, Bengal Staff Corps.
Cumberlege, H. O., Captain, Bengal Staff Corps.
Baker, F. M., Lieut., 1st Royal Cheshire Mil.

THE CONTROL SERVICE; WITH PRACTICAL SUGGESTIONS FOR ITS IMPROVEMENT TO MEET THOSE DEFECTS WHICH TWO YEARS' EXPERIENCE OF ITS WORKING HAVE EXHIBITED.

By E. B. de Fonblanque, Esq., Deputy Controller H.P.

When nearly three years ago I had last the honour of reading a paper in this room, I endeavoured to describe the nature of the great change in our system of Army supply then in course of progress, as the consequence of the suggestions contained in the Report of the Royal Commission, under the presidency of Lord Strathnairn. After long and careful preliminary arrangements on the part of the War Office, the new system was started in the beginning of 1870, and the experience of two years now enables us to form a fair estimate of the practical result.

Now, we all know the proverbially disproportionate value of theory and practice, and how wide a divergence experience is apt to trace between the idea as conceived, and the creation which springs from it. It need not, therefore, be a matter of surprise that the Control system, when it appeared in the flesh, differed very considerably from what it was in the spirit, and that, when practically tried, it fell short in some important points from what was contemplated by its authors and advocates. Lord Strathnairn's Committee was composed almost exclusively of military Officers, and their report was received with favour by the Horse Guards; but when the scheme came to be manipulated by the War Office, and "Control" was finally launched, the result was not at all what was expected, and the military authorities were in the position of the hen who, after careful incubation of what she fondly supposes to be her own eggs, finds that she has produced a web-footed brood, who, instead of nestling under her wing, take to an element quite foreign to her tastes and nature.

I confess that I greatly regret this divergence from the original scheme; I am inclined to believe that the defects discovered in the working of the new system may be mainly traced to this cause, and that had the War Office adhered more closely to the principles as laid down in the Report, Control would have been rendered more acceptable to the Army, and therefore more conducive to the interests of the public.

Fortunately, the experiment has been tried under the favourable circumstances of a period of peace, and it is well for us that we have had ample opportunity of testing the new system without incurring any serious risk to military efficiency; and that we are enabled, not only to find out weak points, and to trace the causes of weakness whenever it is discovered, but to apply at once such practical remedies as experience may suggest, to remove a superfluous wheel here, to strengthen the machinery there, and gradually to bring the whole system into such working order as shall render it fit to bear the strain and shock of war. The remarks I am about to make, are intended to facilitate this end; and if, in the course of my observations, I should appear to dwell overmuch upon the defects, and not sufficiently upon the merits of "Control," let me plead that I do so in the most kindly spirit, as dealing with a thing, in the origin and development of which I bore a part, however humble, and in the honour, success, and welfare of which, I shall ever take the warmest interest.

I may remind you that the gist of Lord Strathnairn's Report was a recommendation that the various existing departments charged with the supply of provisions and warlike stores, with the direction of transport, hospital, and barrack arrangements, and with the control and detail of finance and expenditure, should be amalgamated, and formed into one Executive Department, and that a staff of officers, specially selected for the purpose, should be placed at its head, to direct and administer the various services in concert with, and in strict subordination to, General Officers in command. I will now proceed to show you what has been the result of this recommendation.

The Administrative Branch of the new service is composed of 57 officers, of whom 26 are members of the old Commissariat, 15 of the Military Store, 4 of the Purveyors, and 2 of the Barrack Departments;

in addition to these there joined on probation, one Lieutenant-Colonel of the Royal Engineers, one Lieutenant-Colonel of the Military Train, and 8 Captains or Majors who had passed through the Staff College.

The Executive Departments are composed of 340 Commissaries and 70 Paymasters, there being three ranks of each. These have been drawn from various sources, including Commissariat and Military Store Officers, Barrackmasters, Purveyors, Officers of the Military-Train, Subalterns of the Line, War-Office clerks, and non-commissioned officers from the Army-Service-Corps, the Military-Train, and the Line generally.

The old Commissariat Staff-Corps, Military-Staff-Corps, and Hospital-Corps have likewise been amalgamated under the unmeaning title of "Army-Service-Corps" (Army Supply Corps would have been a much better name) and two Assistant-Controllers and 50 Commissaries are detailed for the officering of this body, which consists of 2,514 non-commissioned officers, rank and file, and is divided into two sections, the one furnishing transport of every description, and the others providing clerks, artificers, mechanics, and the various tradesmen and labourers necessary for purposes of Army supply.

Under the old system, each Department required its distinct representative in every garrison, quite irrespective of the extent of duty to be performed; but now Commissaries are supposed to be generally available for the performance of any supply service that may devolve upon them, whether in connection with provisions, warlike stores, transport, hospitals, or barracks. Among the older Officers who have passed the best years of their lives in one particular branch, it has not been found expedient to carry into effect this part of the scheme, but among the juniors it has been introduced with the best effect, and with a very great economy of labour, as strongly testified by Sir Garnet Wolseley, with reference to the "Red River Expedition," the only occasion upon which Control has been practically tested on active service. The force employed upon that expedition was a small one, but the difficulties to be overcome were of an exceptionally formidable nature, owing to the badness or entire absence of roads, the condition of the country to be traversed, and the length of the line of communication necessarily maintained. The success of the Control arrangements was due in a great measure to the fact, that the Controller was a man thoroughly qualified for his post and in the full confidence of his Commander; but I am disposed to attribute no small portion of it to the circumstance that the Red River was a long way from the War Office, a circumstance which made it impossible to impair the efficiency or weaken the responsibility of the General or his Controller by officious interference. Given a good Controller, knowing his work and not fearing responsibility, and I will venture to say that his success will bear an exact proportion to the distance which separates him from Pall Mall, and the greater or less degree of confidence reposed in him by his General. I believe that most of the failures in the new system will be found to bear reference to these two conditions.

One of the grounds upon which the amalgamation of Supply Departments recommended itself to public favour was, the pecuniary saving which it promised to effect, and it may not be out of place if I here show you by a comparative statement of the cost of the two establishments, how far these expectations has been realized. My figures are taken from the Army Estimates for 1867–68 and 1870–71, and though not perhaps quite accurate, will be found sufficiently approximate to the actual expenditure to answer the purpose of comparison :—

Comparative Statement—Estimates 1868–69 *and* 1871–72.

Numbers.	1868–69. Old Systems.	£	Numbers.	1871–72. New Systems.	£
206	Commissariat	86,861	57	Controllers	31,753
97	Barrack	21,195	340	Commissaries	80,254
85	Purveyors	18,000	70	Paymasters	19,082
184	Military Store	50,130		Subordinates	21,469
	Corps.			Wages, including working pay	161,134
601	C. S. Corps .. including clothing	23,366	2,514	Army Service Corps including clothing	99,769
400	M. S. S. Corps	16,414			
1,004	A. H. Corps*	33,190	1,000*	Army Hospital Corps	31,834
1.798	Military Train	79,790			
	Subordinates.				
	Commissariat including working pay	33,838			
	Barrack	32,482			
	Purveyors ..	9,162			
	Military Store	117,101			
4,375	TOTAL	521,524	3,981	TOTAL	445,295

Shewing a difference of £76,229 in favour of the new system, which, in a financial point of view, may thus be considered a success.

Having shown you what the "Control Department" *is*, I shall now proceed to tell you what it *does*, or what it is supposed and expected to do; before going further, however, I wish to express my concurrence in an objection largely shared throughout the Army to the name of "Control" and "Controller," more especially as applied to the Executive Departments. That the directing body of Officers placed at the head of the "supply services" should bear that name is intelligible, for their peculiar function is control over the expenditure of money and stores, and the various duties therewith connected, and as far as they are concerned I see but one objection to this title, and that is, that it conveys a certain assertion of supremacy and superiority quite incompatible with that subordination to military authority without which the system could not endure for a day; but to call the Executive Department, "Control Department," or the Executive Officers "Control Officers," is about as sensible as if we were to call the Volunteers the "Inspection Corps," because there is a body of Officers appointed to inspect them. Oddly enough, while in the smallest garrison there is some agent calling himself a "Control Officer," the Head of the Department at the War Office, by his title disassociates himself from control altogether, and is called Surveyor-General of Ordnance, which is much as if the Commander-in-Chief were to drop his claim to General Command, and call himself Surveyor-General of Cavalry. These objections may appear trivial, but practically names count for a good deal in the Army, and it is of real importance that no Officer should bear a title which conveys a false impression of the functions he performs.

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* These figures comprise the whole of the A.H.C. Purveying and medical branches have not yet been divided.

This brings me to another feature of the same subject. There has been a good deal of discussion as to the propriety of extending titular Army-rank to the Controllers, and their subordinates, and the question is one involving much more than personal considerations, and admitting of a good deal of argument on either side. I have just said that a title should be as far as possible indicative of the duty, and to propose calling a Controller or a Commissary, Colonel or Captain, may appear inconsistent with that opinion, and yet I am not quite prepared to give up the point. The existing "Control Department" is in all its branches largely recruited from Military Officers, and comprises a corps formed of enlisted soldiers, equal in numbers to four Infantry battalions, and which, although not employed on combatant duties, requires to be as strictly disciplined, as carefully drilled, and as much maintained in military order and subordination, as any regiment in the service. Controllers, and their subordinate Officers are, as regards their immediate branch of the service, invested with the same command as Regimental Officers; they sit on Courts-martial, and they take precedence according to their relative Army-rank. There certainly is something anomalous in such a state of things, and though I, speaking for myself personally, should have felt myself in a very false position had I, after being called Mister for thirty years, found myself suddenly dubbed Colonel, I am by no means sure that military rank (command being strictly limited to the Department) would not prove beneficial as far as the public interests are concerned, by strengthening the hands of authority and facilitating the maintenance of discipline. The soldier is a creature of habit, and it must puzzle him, and rather confound his ideas of right and wrong, to find the Captain of his company, and even the Officer at the head of his brigade (who by the way was a full Colonel in command of a distinguished corps before he became Controller) bearing a civilian designation. I am not insensible to the difficulties which beset this question, but now that the "Control" staff is in a great part drawn from the military staff of the Army, it becomes a very pertinent matter to consider whether it were better for the public interests to convert these soldiers into civilians, or to convert the civilians into *quasi* soldiers. I have no hesitation in stating my opinion that in drawing a proportion of our recruits from the Staff Officers of the Army, and thus bringing not only military experience, but high educational attainments to bear upon questions of administration, the Control Service has greatly strengthened itself; I will go further and state, that if it would have been practicable (and I believe the difficulty of such a course was more apparent than real), to have swept away the superior Officers of the old Supply Departments, and formed the Control Staff exclusively of qualified Staff Officers, the system would have worked much better than it has done, and would have been at once brought into complete harmony with the Army generally. I do not stand alone in this opinion, and may take this opportunity of mentioning that one of our ablest and most efficient Controllers, on being appointed to the charge of a very important post, suggested, with a public spirit and disinterestedness worthy of all praise, that the appointment should be conferred upon the Quartermaster-General on the station, rather than upon him, feeling sure that the new system would thus have a better start; and he offered, in the event of his suggestion being complied with, to serve under that Officer and afford him the benefit of his departmental experience. He knew the value of military rank in any position involving intimate contact with the different branches of the Army. Doubtless many Control Officers will entirely differ from me, and indignantly refute my views; "What," they will say, "what can a military staff-officer know about 'finance' and 'supply,' and 'transport,' and 'account' and the various duties devolving upon Controllers?" To this I will reply, that a good Quartermaster-General, through whose agency all supply-services were formerly conducted, who was the medium of all departmental correspondence, and actually, though not nominally, the local referee upon all questions relating to supply services, should have acquired a greater *general* knowledge of administration than the members of any one of the old departments, whose experience was necessarily restricted to his particular branch. Without wishing to exalt the immediate service to which I myself belonged for many years, I may venture to say that a Commissariat Officer's field of duty, comprising as it did not only the provisioning of troops in all branches and under all circumstances, but the conduct of large financial and monetary operations, the organisation and direction of transport and the formation of contracts for all army services, afforded a better training for the general duties of a Controller than could possibly be possessed by other departmental officers, whose duties confined them to a more restricted field, such as the receipt and distribution of warlike stores, the interior economy of a hospital, or the custody of barrack buildings. Yet, I assert that, with all his superior qualifications for the exercise of administrative supervision, the best Commissariat Officer would not in his capacity for general control be superior to the best Quartermaster-General. The latter, it is true, might be, and in all probability would be, ignorant of finance in its higher branches, and of details upon other points; but this deficiency exists equally in three of the four Supply Departments which furnish Controllers, and would be compensated for by more extensive administrative knowledge acquired by contact with several departments instead of with one only; by the practice of organisation inseparable from his position; and, last, not least, by his military training and experience and (presuming him to have passed through the Staff College) his high educational acquirements.

The system of appointment to the Control Department is curious when it is considered how much of the success of the experiment depends upon individual qualification. As a rule, every superior Officer who by dint of service had attained a certain position in the late Commissariat, the Military Store, the Purveyors, or the Barrack Department, was, if not notoriously disqualified, promoted to be a Controller, and that system prevails to this day; the seniors of the old services stepping, almost as a matter of course, into the new and greatly extended position. Now, I admit the difficulty of the case. With a number of men of different departments proclaiming their merits, clamouring for their rights, and bolstering up their claims by whatever private or political influence they could bring to bear, it was perhaps the easiest course to make seniority the rule; it saved trouble and heartburnings, and the authorities escaped the suspicion of partiality or favoritism, though in some instances at the expense of the public interests. But then the question naturally occurs, "Why exact from military candidates the highest educational test known to the Army, while departmental candidates are subject to no test whatever?" I shall be told, "in order to compensate for the want of technical knowledge;" but I have already shown that this technical knowledge on the part of departmental officers is, as a rule, limited to one branch of administration, and as military candidates are required to serve for two years on probation, during which time they can practically acquire a thorough knowledge of each branch,—they start, even in this respect, with some advantage over the average departmental officer. Now it appears to me quite clear, that either we exact too much from the military or too little from the civilian Controller, and I incline to think that the latter is the case, and that if the present system of mixed appointments continues in force, that every departmental officer should be subjected to an examination of a character which will ensure his equality, as a man of knowledge and education, with the officer who has passed through the Staff-College.

I do not hesitate to say, that although there are other causes at work which have hitherto impeded the successful working of the Control scheme, that the indiscriminate appointments of men possessed of no qualification for the responsible post conferred upon them, has been a great stumbling block. Financial considerations had, I doubt not, to be consulted in these appointments—but it is a very false economy to promote a man to a higher post simply because he served respectably in a lower one; and the course pursued in the limited sphere of the Control appointments does not inspire one with much confidence in the future, now that the wide field of Army promotion is to be regulated with reference to fitness rather than seniority. Seldom perhaps has a great change been conducted with so little favouritism or partiality, as the amalgamation of War-Office-Departments, but I am sure that the timid and respectable course pursued has proved more mischievous than bolder tactics would have done, even though tinged with a certain amount of jobbery. In time of peace, no more serious mischief is likely to arise, even from an incapable Controller, than a loss of departmental credit and prestige, and occasional inconvenience to the troops; but the case would assume a much more serious aspect, if men possessed of no higher qualification than a respectable knowledge of one branch of supply-duty acquired at their departmental-desks, had to be entrusted with the Control charge of a body of troops in the field, in time of war. During the late Autumn Manœuvres, some of the Supply Officers had to be relieved from divisional duty because they did not know how to mount a horse, or having mounted it, how to retain their seats, and I am by no means sure that this and greater shortcomings would not be discovered in some of our Controllers, to whom an arm-chair is more congenial than a charger, and who have been advanced to a greatly extended position of responsibility, and an entirely new sphere of action, simply because for a long series of years they conducted themselves with propriety as clerks or accountants.*

The questions I have raised as to the extension of military rank to the members of the Control services, the expediency of making it a purely military, or a more purely civil department than at present, the system of promotion by seniority from the Supply Branches and other points connected with the subject, appear to be matters fairly open to discussion, upon which I should be much pleased to hear the opinions of some of my audience.

At the risk of becoming tedious, I must once more beg to call your attention to the Strathnairn Report, which was the corner-stone of the present edifice, however much the fancy of the architect or the shortcomings of the builder have altered its original character and the leading principle of which is "a better division of labour, and a greater concentration of responsibility." Any one who will read the report with ordinary care will note how steadily that principle is kept in view throughout the various and multitudinous details which are necessarily discussed. The Commission was formed of practical men, thoroughly conversant with the wants of the service, and who endeavoured to remedy the existing waste of power, and confusion and extravagance, and to devise, by the light of their experience, a simple and intelligible system of Army Supply. What they said was in effect this:—"Here we have in every garrison at home and abroad some half-"dozen departments playing at cross purposes with one another at the "public expense, each directed by its own distinct head, acting under its "own distinct regulations, and corresponding directly on local matters "with its own distinct chief at the War Office. Let us remedy this state "of things by placing all these departments under the local direction of "one man, with a view to united instead of divided and antagonistic

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* It is told of Sir James M'Grigor that, great pressure being put upon him while he was at the head of the Army Medical Department in favor of a notoriously ignorant man who was a candidate for the post of Regimental Surgeon, he finally yielded to the importunities of his friends, and conferred the appointment, upon condition that the young man gave his word of honour that he would never, under any circumstances, adminster any medicine except Epsom Salts. Sir Henry Storks would, in the event of a war, have to impose similar restrictions upon some of his Controllers.

" action, and placing that one man under the General in local command " as his adviser, agent, and mouthpiece on all matters of finance and " supply. The troops will thus be better served, the General Officer " will be relieved of a mass of detail and correspondence which now " occupies so much of his time, and the public will save money." This was a practical common sense view of the question, with a logical solution in the shape of the Control scheme for its result.

Now, had it been possible to have left the practical development of the scheme to the same body as that which originated it, I have no doubt "Control" would by this time have been in a very different condition from what it is, but the Commission had completed their task when they signed the Report; like a jury in a court of justice, they gave their verdict, and it was for another agency to pass and to execute the sentence; and here I must beg of you, to bear in mind the very peculiar condition of our institutions in respect to the administration of the Army, and that dual government of which so much has been said of late years, and which, in the opinion of a very large number of well-informed people, is supposed to be of modern date, and consequent upon the establishment of a War Ministry. I think, however, I shall show you that this antagonism between the civil and military element is nearly as old as the constitutional Army itself. It is now nearly 200 years ago—the Act is dated 1676—that a Parliamentary officer was appointed to watch and control military expenditure on behalf of the House of Commons; and in a very remarkable State paper drawn up by Lord Palmerston (and appended to Sir Henry Bulwer's Life of that statesman) you will read how, during those two centuries, successive Commanders-in-Chief habitually presented and resisted this restriction upon their authority. Just 60 years ago, in 1812, when Lord Palmerston was Secretary at War, and Sir David Dundas Commander-in-Chief, there was an open conflict upon the rival pretensions of these two officers, the latter complaining of the gradual encroachments of the Parliamentary element as derogatory to the dignity of the Commander-in-Chief and subversive of the discipline of the Army, while the former asserted his right to control military action and to form, as he expresses, "a sort of barrier between the military officer in command of the Army and the civil rights of the people."

Now, in a political point of view, the struggle was virtually ended by the appointment of a Cabinet Minister supremely responsible for the efficiency of the Army, but you cannot abolish the traditions and habits of ages by an Act of Parliament, and as long as the Secretary of State for War is, as he must as a rule be, a civilian incapable of assuming military command, and therefore compelled to delegate it to another, so long will the military element refuse to be completely merged in civil administration. Circumstances may modify the power of the resistance, and mutual tact and judgment may so far soften the asperity of opposition as to produce a working compromise—but the arm which actually wields command, will always be the stronger arm in the opinion of military men, and the soldier, no matter whether he be a private or a general, will never be brought to entertain the same sentiment of personal respect and deference for a political agent, no matter how highly placed, as he would for a military commander. While such feelings exist (and after all they are almost inseparable from a true military spirit) so long will there be antagonism in the government of the Army, and so long will the complete subordination of the Army to civil authority continue to be a political theory only. The broad distinction between our system and that of Continental Armies lies in the fact, that, with them, the War Minister is also Commander-in-Chief, subject only to the will of the Sovereign,and as a rule a distinguished General, chosen for large and varied experience in every branch of the Service, capable of entering into the feelings of the soldier, of understanding his wants, of identifying himself with his interests, and equally versed in the art of war and the science of administration. We might possibly find Generals possessed of all these qualifications—there is no reason why the Prussians should have a monopoly of such men as Moltke and Von Roon, nor do I believe that they have—but it could only be by a most rare and extraordinary combination of circumstances that such a General should possess the political training, experience, and influence which alone could obtain for him admittance into the foremost ranks of political life, and thus, although a professional War Minister might prove the means of solving a serious difficulty, fulfilling at once constitutional obligations and military requirements, such a thing is barely within the bounds of possibility, and we must therefore make the best we can of existing conditions.

I must apologise for this apparent digression, but the actual relations between War-Office and Horse-Guards have a material bearing upon the subject of my lecture.

No sooner was the Strathnairn Report in the hands of the War-Office, who knew that its suggestions met with the approval of the Horse-Guards, than they took alarm at what they chose to consider military encroachment upon the constitutional province of the Secretary of State. The leader in this attack was a gentleman then holding a high position in the War Office, but now removed to a less stormy sphere of public usefulness, a gentlemen of very superior ability and for whose character I have the greatest respect, however much I differ from his opinions. Well, he denounced the scheme as fraught with danger, not to the Army—that was always with him, and the branch he represented, a secondary consideration—but to the War-Office and to the public purse, and when Sir Henry Storks and General Balfour were appointed to consider and report upon the best means of giving practical development to the plan, the opposition increased ten-fold. Now, Sir Henry Storks is, as we all know, a very distinguished administrator, who for the last twenty years nearly has been employed in high civil duties, and General Balfour is well known for the part he had taken in connection with financial reforms in India; but both these gentlemen happen to be soldiers as well as administrators, and so the War-Office saw in them that small end of the wedge which alarmists are always discovering, and resisted them as zealous gamekeepers would resist trespassers upon their preserves. I dare say some of my audience may remember how these apprehensions found an echo in two influential newspapers at that time, and how the "Pall Mall Gazette" and the "Saturday Review," in flourishing leaders, proclaimed the imminent peril to which the Constitution was exposed by "the Horse Guards' Plot," and how General Officers, with the aid of Controllers, were going to usurp the functions of the War Minister, play at "ducks and drakes" with the public money, and dragoon the House of Commons.

This is, I assure you, no exaggerated statement of the arguments used. I do not know whether these newspapers gave their tone to the War-Office, or whether the War-Office inspired the newspapers, but the two agreed in this line of opposition to the progress of the Control scheme, and not without effect. It must be remembered that decentralisation was one of the prominent features of the new plan, and that decentralisation meant the transfer of a great deal of business from the War-Office, to local agency in every garrison or district at home and abroad. Now, whatever tended to reduce labour, tended to reduce establishments, and if the appointment of Controllers involved the dis-establishment of War-Office Clerks, why, making allowance for human nature, it need not be a matter of surprise that the threatened officials cried out very loud and used all means to prolong their existence.

But the authorities were committed to action in the direction of "Control"; it was impossible to burk Lord Strathnairn's Committee; on the other hand, the opposition was formidable. Might not a compromise be effected by establishing nominal Controllers, but giving them nothing to control, and leaving the power and action of all branches of the War-Office intact? Some such idea probably arose; at any rate, by the time the scheme took shape, it was so altered that its originators were unable to recognise their offspring, and the military authorities, who had seen in the plans of the Royal Commission a practical measure beneficial to the soldier, could now only discover a huge machine, calculated as they thought to weaken the responsibility and lower the dignity of military authority. The poor Controller thus found himself between two fires, the War-Office considering him a poacher in the military interests, prowling about to find an opening into their covers—the Horse-Guards looking upon him as an officious, meddlesome fellow, anxious to carry War-Office pretensions into every garrison, and to swagger before General Officers in the name of the Secretary of State. It was not a pleasant position to start from, as I can testify from personal experience, when I was first appointed to establish the new system in a Home District, and as my case was that of most others, I may quote it as a fair example. In the first instance, I applied for instructions, but no instructions had been prepared; I would arrange matters for the best in concert with the General in local command. Well, this was at any rate flattering, as it left much to my discretion and invested me with a degree of responsibility, which at once gave me an exceptional interest in my work, so I joined my station and found a General who gave me a cold shoulder, a Staff who treated me as an interloper, a garrison who did not know what I was and why I came there, and the usual number of "Supply Departments," smarting at the loss of their independence, and not too well disposed to pull together in the new team with a strange coachman on the box. Personally, I had certainly no reason for complaint, and I was on friendly terms with all, but I could not help feeling that nobody wanted me in my official capacity, and that the only support I had to expect in my task was from the War-Office. I made a mistake there. My General was too thorough a soldier not to afford me that recognition which his duty required of him; but he did no more, and if a Staff Officer had met with such an official reception from the Chief to whom he came to be attached, he would have been much tempted to resign his appointment. It was impossible for me not to become aware that I was viewed with suspicion, that confidence was withheld from me, that my opinions were not likely to be consulted, and that when offered, they were very likely to be disregarded. It is not easy to break through old habits; and it was not without an evident effort that the General, in obedience to instructions, allowed me to supersede his accustomed Staff-Officer in the transaction of administrative duty, to obtain and convey his decisions directly instead of through the former channel, and to deal with matters which hitherto had been considered as falling within a purely military province. Staff-Officers were equally unwilling to cede any portion of their accustomed privileges, and Commanding Officers of regiments did not all approve of carrying their complaints and grievances with regard to finance or supply to the Controller direct instead of to the Quartermaster-General. However, every new system has its difficulties at first starting, and the time will come, I thought, when the General will find out how much trouble a Controller may save him; I soon discovered how powerless I was, and in illustration of the actual system, will quote one case. A claim was made on behalf of a small body of troops for a trifling allowance to add to their comfort under exceptional circumstances; under the old system this would have involved considerable delay and long correspondence, as happened once to my knowledge when an application for additional fuel on account of a very severe winter was not finally granted by the War-Office until the dog days were setting in; but "Control," if it means anything, means local decision on such points, so when the General expressed a strong opinion that the claim was a just one, the Controller concurred in his view, and ordered the issue, reporting to the War-Office what had taken place, and feeling rather proud of this practical proof of the advantages of "Control;" when lo! back comes a Minute disallowing what had been done, and surcharging the Controller with the value of the issue. It was from such cases that I soon learnt, what has since become generally known, that neither a General nor a Controller has the power to authorise the issue of anything not provided for by regulation, and that if they presume to do so, from mistaken feelings of interest in the comfort of the soldier, they must take the consequences. Such cases as the one I have quoted, are not calculated to improve a Controller's position; instead of helping the General, he had caused him to be snubbed, and his confidence in the Controller was more than ever shaken. Now, I would not cite such an instance were it not that, to my certain knowledge, it is laid down as an absolute rule, that neither the General nor the Controller on a Home Station has the power to carry any measure, however urgent or beneficial, without first obtaining the authority and approval of the War-Office, and, as in many of these cases the circumstances upon which exceptional claims are founded, are of a nature which a War-Office clerk, ignorant, as he necessarily is of local and military detail, cannot appreciate, it frequently happens that the comfort of the soldier is sacrificed to this stupid adherence to red-tape and the cause of clerkdom.

Now, if a Controller is allowed no discretion, why does he exist at all? According to the spirit of the Report, which I take for my text, the General Officer in command is supreme, and the local representative at once of the Commander-in-Chief and of the Secretary of State. He has at his right hand his military Staff-Officer to assist him in discipline, at his left, his Controller to assist him in administration; but under present arrangements the General, though allowed a wide discretion by the Horse-Guards, is allowed no discretion whatever by the War-Office. By the former he is entrusted with the efficiency, the health, the comfort, and the general welfare of thousands of soldiers; by the latter he is virtually prohibited from ordering the expenditure of sixpence, the issue of an extra bushel of coals, or of an ounce of bread, even though their own agent should fully concur in its necessity. The War-Office is reluctant to entrust power to an agent of the Horse-Guards, so they place at his side an agent of their own; but lest he again should fall under military influence, or usurp, or weaken central-authority, they place over him an agent of the War-Office, without whose approval, previously obtained, local action is invalid. So we have local Controllers with nothing to control, and local Paymasters with nothing, or next to nothing, to pay; the corresponding branches of the War Office assuming all their responsibility and undertaking nearly all their duties in order to justify their official existence, the necessity for which I very strongly doubt. We have thus double "Control-Establishments,"* involving much correspondence, delay, and expense—*diluting responsibility*, which it was the great object of the Control scheme to strengthen, and *strengthening that centralisation* which it was its aim to destroy. If local Controllers are not to be trusted, abolish them, and let War-Office-clerks, in Pall Mall, do their work; but let this be done openly, so that we may know where responsibility is due, and do not let us keep up the show of Control in every garrison, and the reality of it at every War-Office desk.

I now come to a point upon which much diversity of opinion prevails both within and without the Department. Under the old system, the custody of warlike stores was entrusted to what was formerly called the Civil Branch of the Ordnance, and ultimately became the Military Store Department; but as the members of this Service were as a rule, devoid of scientific knowledge, Artillery Officers were appointed to act as Inspectors while they were the Custodians of warlike stores; this professional element has now been withdrawn, and the whole duty connected with Arms and Ammunition, excepting their manufacture, has fallen within the province of Control. I speak from experience when I say that Controllers are as a general rule, unequal to the direction of these duties; I certainly felt myself in a false position in this respect, and had either to talk about things which I did not understand, or own my ignorance, and consequently, in so far, my unfitness for my post. I believe others have found themselves in the same predicament, and that the majority of Controllers are satisfied that the administration of Warlike Stores should devolve upon a special staff, to be attached to the Royal Artillery. Here again, probably, the civil element will step in with its veto; but surely if the War-Office can entrust the direction of ordnance manufactories, with the large expenditure they involve, to Artillery Officers, they might in like manner entrust to them the administration of the stores when manufactured, under such restrictions and regulations as they should consider necessary. The non-warlike stores, indeed everything not coming under the head of "Ordnance," should remain in charge of the Control Department, and such a division of duty would be easily carried out, since in reality there is no connection between the Ordnance Branch and the Supply Services, the so-called Controllers of Arsenals performing no general Control duties, and the old Military Store Branch under its distinct head continuing intact at the War-Office. I should be very glad to hear this question discussed, knowing that much may be said on either side.

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* An experienced Controller states, that were war to break out, the first duty which the War-Office would impress upon him would certainly be the collection of those innumerable and various printed forms, which have been invented apparently for no other purpose than to afford gentlemen in Pall Mall occupations and a pretext for interference in matters of executive detail.

A few words on the Army Service Corps, which requires reform, though its defective working is less due to inherent faults, than to that *centralisation* and War-Office meddling in executive detail, which proves so fatal to the branches of the Control Services.

It is an understood thing that a General Officer is responsible for the working condition not only of the men but of the horses within his command. Were the Commander-in-Chief on an inspection to find the horses of a cavalry regiment or of a battery of field-artillery in bad order, he would "pitch into" the General, who might in his turn "pitch into" the Commanding Officer, but to whomsoever the blame should be attached, it would necessarily be to some local authority. Now the Army Corps service is according to regulation, in all that regards discipline as much under local military authority as any battalion of the line, and like other corps, is periodically inspected by the General Officer. Let us suppose such an Inspection, and I am going to cite an actual and not a supposititious case. The General says to his Controller, "I don't like the condition of the transport horses—they are too poor; they have hard work, and you ought to have applied to me to sanction the issue of extra forage for them." "Very true, Sir," says the Controller; "but the War-Office have decided that they were not to have extra forage for the next six months"; or, as also happened:—"Don't let me see your waggons carrying heavy loads with only two horses—it's cruelty to animals!" "So it is, Sir," says the Controller, "but the War-Office has strictly forbidden me to employ four horses under any circumstances." Well, I will not say what would be the answer of many a General; his remark upon the War-Office would probably be short and emphatic;—but how, let me ask, can local responsibility be enforced while such proceedings take place?

I have referred to the indiscriminate appointment of executive supply Officers to the Control-Staff as detrimental to its efficiency; the same system prevails in appointments to the executive departments, and especially to the Army-Service-Corps, and much mischief has been done by the promotion of Non-commissioned Officers to the rank of Commissary. Now, I am and always have been favourable to opening the avenues of advancement to merit wherever it is to be found, and I believe that judicious promotion from the ranks would be a positive benefit to the Army as well as an undoubted justice to individuals; but as a man, because he is a respectable Commissary does not of necessity make an efficient Controller, so another because he is a good Non-commissioned Officer does not of necessity, or even by presumption, make a good Lieutenant or an efficient Commissary. It is not because a man is a well-conducted Serjeant that I would promote him, but because he is too good to remain a Serjeant and qualified for the higher post by superior professional acquirements and education;—this important condition appears to be quite overlooked in appointments to the Supply departments.

It is indispensable for the proper working of the "Army-Service-Corps," that there should be a superior Staff-Officer attached to the head-quarters of the Corps for the purpose of keeping its records, performing duties corresponding with those of the Adjutant-General of the Royal Engineers at the Horse Guards, but he should not interfere in anything affecting local discipline or detail which should devolve entirely upon the General in Command, and upon his Controller as the immediate Commanding Officer. Such an Officer, if of sufficient standing in the Service, would also act as a rallying point for the members of the department generally, who have at present no ostensible chief. The Surveyor-General is too much occupied with his Parliamentary duties to receive his officers (though why the Head of the Control Department should be a political officer is to me quite unaccountable); he has two assistants, but they are concerned with *materiél*, not *personnel*, and so when an old officer who has been knocking about all parts of the world for thirty years or upwards, and has attained a high position, finds himself at Head-quarters, he has to go, hat in hand, to a young Clerk—who is called Private Secretary—and beg the favour of being allowed to apply for a few weeks' leave of absence. The present Private Secretary happens to be an amiable and gentlemanly man, but such an arrangement places him as well as the Departmental Officer in a very false position.

There is only one more point to which I will refer. In Lord Strathnairn's Report, the necessity for some connection between general and regimental "Supply Services" has not been overlooked, but no action whatever has been taken in this direction. It may be remembered that during the Autumn Manœuvres, there were frequent complaints on the part of bodies of troops, that they had been left without food for longer or shorter periods. Now there was a complete establishment for supply duties under a Controller attached to each division, and there certainly was never a want of food in their magazines or depôts. How, under such circumstances, could a corps remain unprovided? I will tell you, for I took the trouble to enquire particularly into those cases, and I found that in almost every instance the fault lay with the regimental Quartermaster, who, instead of applying to the Commissary of his brigade, waited for the Commissary to find him out and to offer his services. In one or two cases the distance of the depôt from the regimental encampment made communication difficult, for although Quartermasters were provided with horses while employed on this service, they, like some of the Commissaries I have mentioned, were not disposed to trust themselves in the saddle; but the real cause of these failures was the want of a connecting link between regimental and general supply duties. The Quartermaster as he exists, is an obsolete institution, originally the result of the necessity of providing for an old soldier in a manner suited to his position; but under our present organisation, he is a living anachronism. He should be abolished, and in his place we should have an Assistant Commissary attached to each battalion, and charged with regimental supply under the responsibility of the Controller. I am inclined to think that a similar arrangement with regard to regimental Paymasters would prove beneficial, and I am by no means sure that the duties of regimental Paymaster and Quartermaster might not be united in the person of one Commissary.

I am afraid I have trespassed upon your patience and indulgence, and that I have been somewhat severe in my criticisms, but it is precisely because I believe in the soundness of the principle of the "Control" system that I do not hesitate to denounce its defective development. A friend, for whose judgment I entertain the highest respect, wrote to me lately:—"You ask me to name the principal defects of 'Control;' well, keeping in view the Strathnairn Report, I should say that its principal defect is, that it does not exist." Now this is perfectly true; the present Control system is like Ronaldo's horse, which possessed every equine virtue under the sun, but had one fault—it was no longer alive.

The CHAIRMAN: The subject is a very important one, and it is my duty to invite discussion. If any gentleman wishes to make observations on the general subject, or on the details of the lecture, we shall be glad to hear him. It is generally understood that each speaker is allowed ten minutes, and, probably, he will be able to compress his remarks within that space of time.

Assistant-Controller CROOKSHANK: Mr. Chairman, I see there is some slight hesitation on the part of gentlemen present to get up and make remarks upon the lecture which has just been given. I venture, in the first place, to say, that it is a matter of immense pleasure to me, as an Officer of the Department which has formed the subject of the lecture this evening, to see so many Officers present. It is so very much the custom to cry down "Control," so very much the custom to find fault with it, even amongst those who know nothing about it, and perhaps more by them than by those who do know something about it, that the large attendance of Officers here to-night satisfies one that there is within reach of this Institution members who are willing and anxious to hear, and probably to learn something connected with Control, and pick up some crumbs of information—may be those crumbs will eventually resolve themselves into loaves of suggestion. I must say that we Control Officers labour under a very great difficulty, a difficulty that our lecturer does not labour under. He is on the Retired List; he can write; he can say what he pleases. We are, as you know, tongue-tied, pen-tied. We can neither speak nor write, we have not the opportunities to express ourselves as openly, as plainly, and as audibly, as to the nature of our service, as we would be willing to do. The lecturer to-night has reflected very strongly indeed upon War Office interference. I am sure that both yourself and he, and all here present, will excuse me from touching upon that subject in any way. We are servants of the War Office; and, I take it, very faithful servants of the War Office; that we carry out the instructions of the War Office, not only to the best of our ability, but to the best of our power. Having said that much, I will not allude any further to War Office questions, but rather to the general subject of Control. If I remember right, the Duke of Wellington once said, with a feeling of pride, "If I can do anything in the world, I can feed an army." When he said that, he did not mean he could feed the British soldier with the traditional biscuit and pork that he eats in the field; but when he said he could *feed* an army, he meant that he could *supply* it with everything, from boots upwards. That is now the province of Control. And if we have General Officers who can say in as bold language as the Duke of Wellington's, "I know how to feed an army," depend upon it that, with existing arrangements of Control, that army will be fed, that army will be supplied, there will be no difficulty, no want. I am perfectly convinced—you may say it is a small experience, but it is precisely the same experience that you have all got here, two years, that is about the age of Control—I am quite convinced that, if we take the field, and Control is carried out in its integrity, that the army in the field will not want. Our army ever has been the best fed and the best supplied army in the world, and under this new system I am convinced it will continue to be so, at less cost and less anxiety to the General commanding it. It requires, however, a General who will take any amount of responsibility—a Controller who has got any amount of capability—responsibility on the part of the General and capability on the part of the Controller—and I am quite sure that no British Army in the field will want anything. Referring to the question of our title, I think if there be a mistaken title, it is that of "Control." The lecturer has exhausted that subject pretty well. But I am sure no one here who has ever heard the title used, will differ from me in saying that it is a title that ought to be abolished, and I have great hopes that it will be abolished shortly. What can be more offensive, to use a mild word, than for an Officer to come up to a General commanding a division, and say, "Who is your Controller?" To him it is offensive; to the Controller it is awkward. Again, Controller applies to five hundred things. There is a Controller of the Household, a Controller of the Navy, a Controller of the Stationery Office; and it was only the other day that I, as a member of the Committee of the Army and Navy Club, had to sit in judgment upon a complaint preferred against the Controller of that Club. No doubt it is a title universally disapproved of, and we all hope it will be done away with. Arises the question, what will you call us? I am not in the confidence of those who are discussing the subject. I believe it is under discussion what we are to be called. We are in great hopes that it will be something very distinctive indeed, something that will give us a proper position, which we do not hold now, and unmistakably distinctive from the military element of the Army. Take, for example, the title of Administrative Staff; a General Officer in the field has his Chief of the Staff. He represents the Military Staff only. The Quartermaster-General, the Adjutant-General, the Military Secretary, &c., all look to him as their Chief. Why should there not be two Staffs, an Administrative Staff and a Military Staff, each with its head. It is a suggestion not my own; it has been thrown out before, and much talked of. Some other gentleman in the course of the discussion may find some other and better title. Apologising as a young officer, not in years I am sorry to say, but in the service, for having intruded so long upon your attention, I have to thank you for listening to me so patiently.

The CHAIRMAN: In consequence of what Mr. Crookshank has said very properly, that the officers of the Control Department are tongue-tied, I think I may say that in a meeting of this sort, no Government would wish, as long as it is fairly done, that any officer, even on full pay, should consider himself tongue-tied.

Colonel **Elrington**, Rifle Brigade: As Commanding Officer of a battalion for fourteen years, I beg to enter my protest against the suggestion that Quartermasters be abolished, and their places be supplied by Assistant Controllers. I am satisfied the system would not work. Quartermasters are a most valuable body of men, and so far from their places being filled by Assistant Controllers, I am satisfied that they cannot be filled at all. They give a great deal of assistance to the Commanding Officer, and they display a great deal of energy and ability. They carry on their duties remarkably well. They are inadequately paid. Their responsibility has been taken a little off lately, and thrown on the Commanding Officer. Still there they are. The whole control of the working of the battalion rests with them in a great measure, and as a body they carry it out remarkably well and satisfactorily, as I can state from fourteen years' experience.

Captain **Home**, R.E.: There is one point I should like to remark upon. With reference to the name Controller, I think if Johnson's Dictionary be referred to, it will show that the word is spelt "Comptroller." Comptroller is a man who deals with accounts and stores; Controller is a man who controls. When the Control Department was first started, as will be seen in the Army List, it was the office of Comptroller that was spoken of. Then, Comptroller was dropped and Controller was introduced. I think the word Controller is one which does not give any idea of control in the sense of comptrolling accounts and stores; whereas Comptroller is a very fair and just term. It is the alteration of "mp" into "n" that has given rise to the objection that has been referred to by one speaker. We have Comptroller of the Queen's Household, and no doubt the Comptroller of the Queen's Household is not a Controller. I think the substitution of one letter for two has led to the difficulty complained of. With regard to the working of the Control Department, I think all orders should come through the chief military Staff Officer. Throughout the whole of the armies in the world, I believe such a thing as any order not coming through the Chief of the Staff is perfectly unknown. I can only refer to *Jomini*, who was a great authority on the subject, and was for many years Chief of the Staff of a large army. He draws attention to the fact that the Chief of "Intendance," the Commanding Officer of Engineers and the Commanding Officer of Artillery, were excessively anxious to deal directly with the General, and not through the agency of the chief Staff Officer. He uses the word "*prétendent*," and the result of such a thing, he says, would be great confusion. He says no General should deal with them, except in the presence of his Chief of the Staff; and all their correspondence should be sent to his Chief of the Staff. I think the principal blot in the Control Department is this fact, that the Controller attempts to go direct to the General. It is a well-established fact that the distinction between the Quartermaster-General and the Adjutant-General's staff is one that has produced a great deal of confusion; and that having one staff would produce great simplicity in our staff arrangements. But here we have a Quartermaster-General's Department, with all the faults of the Quartermaster-General's Department, without any of the advantages it possessed. Another point the lecturer has alluded to, is the division of stores, and I perfectly agree with him. No army in the world, except our Army, has but one Officer placed over the Artillery and Engineer stores, as well as the stores which feed and clothe the Army. That arrangement is perfectly unknown in the world, except in our Army. A very great master of the art of war says "war is not conjectural;" there are certain definite things which must be granted, and which, if once granted, other things will follow from them. I think it must be allowed that we should follow other people in these points. The Artillery and Engineer stores should be decidedly under the Commanding Officers of Artillery and Engineers, and the whole of the department of the Army should be under one staff. Until that is done, I think the Control system, which I highly approve of in many of its details, will never work smoothly. A General Officer should have only one Chief of the Staff, and through him, questions relating to everything should go. He should be the link that unites the civil and military departments together. That is the point where a difficulty arises.

Captain **Hozier**, 3rd Dragoon Guards, Acting Assistant-Controller: I am not prepared to follow the last speaker through the pages of Johnson's Dictionary, or through the French "Intendance." But there is one point in which I think he has made an error with regard to the Control Department; that is, the question of stores. The reason that we differ from all other armies is, that we are a maritime nation. When we make war, we hope that our war will be exterior to our own shores. We must have one single person to whom to consign all stores, or else we shall have the faults of the Crimea over again, when shot and shell and boots, and various other stores, were sent in the same bottoms, but consigned to different persons. The consequence was, ships were sent away loaded with stores, and the greatest confusion was the consequence.

Lieutenant-Colonel **Fletcher**, Scots Fusilier Guards: There is one point to which I should like to draw attention, as I do not think it has been quite sufficiently explained in this paper. It refers to the following paragraph: "Non-warlike stores, " indeed everything not coming under the head of Ordnance should remain in " charge of the Control Department, and such division of duty would be easily " carried out since in reality there is no connection between the Ordnance " Branch and the Supply Services, the so-called Controllers of Arsenals per- " forming no general Control duties, and the old Military Store Branch under " its distinct head, continuing intact at the War Office." The question I wish to ask is, supposing in war-time the *munition de guerre* is separated from the *munition de bouche*, and the warlike stores for the army, the shot and shell stand under charge of the artillery, whilst the clothing, food, &c., is left in charge of the Control, how would the transport be managed? Would the transport for the *munition de guerre* be under the Artillery; and would the transport for the *munition de bouche* be under the Control; or would the whole transport be under the charge of one Department? There is another point I was very much struck with, viz., what was said with reference to the education of Control Officers. If high class education is necessary for Staff Officers, and if there are to be continual competitive examinations, I cannot help thinking that the whole Army comprising its Civil as well as its Military Departments, should be subject to them.

In respect to the Autumn Manœuvres, I think an additional cart attached to a regiment would greatly facilitate the supply of food, if it could be given without other inconvenience.

With regard to another subject touched on in the lecture, I would point out that supposing the Regimental Quartermasters were replaced by some other Officer, it would be absolutely essential that whoever might take his place, should be most completely united with the military portion of the regiment, and entirely under control of the Commanding Officer. Otherwise an injurious element would be introduced into the regimental system, similar to what is said to have been introduced into divisional commands, viz.: that of the Control Officer being rather too independent of the General. Not that I think he would be independent of a really firm General, because I cannot fancy such an infraction of discipline occurring where an army, or a division, or a district is properly commanded.

Mr. F. **Wingfield**, late Deputy Assistant-Commissary-General: There is one point to which I wish to call attention. The lecturer has already alluded to it, but has not spoken definitely. It is the question of the advisability of making the appointments in the so-called Civil Departments of the Army, appointments to be held by purely Military Officers; and of thereby abolishing that anomalous character, an Officer of the Civil Departments, whose place would be supplied and whose duties would be discharged by an Officer of the Army, holding the office as a staff appointment. Would not better co-operation be secured if every officer knew that he had to deal with a Military Staff Officer and not with a civilian, holding merely relative rank, whose real position, in a military sense, is ever being called in question?

Captain **Webber**, R.E.: I venture to offer a few remarks. I think where Control, as now organised, has probably broken down and is most likely to break down, is at the point where it meets those whom it has to supply. That link has not been properly considered. We have a splendid organisation, a splendid Military Staff; we have mind, but we have not the power of bringing that mind to matter. That is to say, we can make our warlike stores, we can buy our food, we can hire our transports; but we have not arrived at that point yet, where we bring those things, and place the food in the mouths of the troops, and place the cartridges in the boxes of the soldiers. It is there, where the chain has broken down; and it is there where we have to make regulations and to produce means which we at present want. I think if this is considered with reference to what has been said to-night, it is in that point alone, that we broke down in the Autumn Manœuvres, and it is in that point that we want experience. A few amongst those have taken part in the discussions on the subject of "the supply of an army," will recollect that we supply our army in India in the most admirable manner. There is no place where the Commissariat is more efficient, and where food and material is more readily brought and placed where it ought to be brought and placed, namely, in front of the soldier. Perhaps, I am speaking to some who have had contrary experience. But that is my experience, and it has always been the experience of those with whom I have talked on the matter. I think the result has been arrived at from this, that the Officers who have been employed to carry out the executive duties of the "Commissariat" have been Officers with whom the soldier and his Officer have sympathy. They have been Officers of the Army who have been selected specially for their "administrative" qualities, who have had great experience with soldiers in the field, who know exactly what is wanted, and how to meet those wants, not merely in their purely administrative capacity, but also in a way which makes the soldier feel that his wants are being met; and seeing that his wants are really being met, he will cease to grumble, he will cease to think that he is not being considered and thought of, and he will feel that the man who is supplying him is anticipating his wants and his feelings, and is doing all he can for him. I think we break down, not because we have not good men and good Controllers, but we break down, in that the soldier and the Officer have constantly on their minds the feeling, that the best that can be, is not being done for them.

The CHAIRMAN: I dare say there are many Officers present who could mention the details of the Indian Commissariat, which has been referred to by the gentleman who spoke last. It might be of great advantage to this Society to hear the details of the system.

Mr. A. S. TOMKINS, Victoria Rifle Volunteers: It appears to me that it is very unimportant whether the Control Department is called the Control Department, or whether it goes under any other name. It also appears to me unimportant whether the Quartermaster is called Quartermaster, or whether he is called Commissary. But it is very important, how the duties are carried out. Having been in a position at the "Autumn Manœuvres," which gave me the opportunity of seeing on certain occasions the working of the Control Department in certain points, it appeared to me, that what might be the cause of a break down, was that the waggons were kept in one place, and the horses were kept in another. In the regiment to which I was attached, so many waggons and so many horses were told off for transport duty. When we marched into camp, the horses were taken out of the waggons, and the drivers and horses had to find their way to the Control camp; which may be in a large division, a long distance from the regiment, and if the regiment arrived on its camping ground after dark, the driver might have great difficulty in finding where the Control camp is: he consequently arrives late, and his meals are distributed irregularly to him. When the army has to move—I believe I am right in saying—a driver is told off with his horses to go to a certain regiment, and it is very possible he may have great difficulty in finding that regiment. I can only say that on several occasions when the battalion to which I was attached, was going out for a field day, we had our ammunition waggon, our water-cart, and our ambulance; perhaps, we had one pair of horses come down, and it was a question with the Colonel which waggon or cart he should take. It appears to me that all that might be avoided if the horses were kept with the waggons. You do not keep your guns in one place and the horses in another for the artillery. With the cavalry, you do not have your men in one place, and your camp for horses elsewhere. Why should it be so with the transport waggons? The man who wants his waggon at a moment's notice ought to have his horses with him ready to put in. In the case of the water-cart, we had one water-cart to four or five battalions; and when it was necessary to fill it, there being no ropes for the men to drag the cart, and often no horses to draw it, we had to wait till the "Control" driver came down with horses and took the water-cart to be filled. The consequence was that often the men had no water for breakfast, or had it very late. In the case of our battalion, after the first week we had a water-cart and a horse of our own, and then we had an ample supply of water. If we required water we could go and draw it, while the regiments adjoining us were deficient on many occasions, and their dinners were put off simply because they had no means of fetching water.

The CHAIRMAN: If no one else wishes to make any remark, perhaps Mr. Fonblanque will be kind enough, if he has taken down the questions, to answer them; I myself will not refer to any particular opinions, although there are many remarks that might be made; but I think it is due to the lecturer that he should reply to the questions that have been put, rather than that I should take them up.

Mr. DE FONBLANQUE: The first question put was, who should have charge of the transport, in the event of the *munitions de guerre* being separated from the *munitions de bouche.* It was one of the great principles laid down in the Strathnairn Report, in fact, it was the foundation of that Report, that you could not attach responsibility to Supply Departments if you took from them the transport necessary for conveying supplies. The original question for the Committee was (if you will refer to the Blue Book you will find this quite clear), the consideration of transport in reference to supply; and the principle laid down was, that whoever was responsible for supply must have full control of the transport connected therewith. Adopting that principle, I should decidedly say, if you hand over to the Artillery the arms and ammunition, you must give them the transport for their conveyance, just as much as you must give them horses for drawing their guns. I think that principle is now fully established; and if we so far depart from the present Control system as to separate Ordnance stores from other stores, you must *to that extent* also separate the transport.

The CHAIRMAN: Perhaps you will let me make one remark with regard to a point which is very interesting to artillerymen and others. Besides the regular powder, shot, and shell, there are 135 different articles that are stores of artillery common to the rest of the army. I think that is a fact. You may comment upon it as much as you like. Horse-shoes, nails, timber; I could mention a great number. I think the number is 135.

Mr. FONBLANQUE: That are acquired for artillery purposes as well as for the army?

The CHAIRMAN: As well as for the army.

Mr. FONBLANQUE: Then, I should argue, you must make a division in these so-called Artillery Stores. You must draw the line somewhere. I should draw the line strictly at "warlike stores," because food and clothing and camp equipage, and even nails, are things that artillery require in common with the rest of the army. They should not have control of such stores. Let the line be strictly drawn at "warlike stores," stores, the custody and administration of which require a certain scientific knowledge; hand those over to a special staff and give them full transport for this branch of supply. A gentleman spoke in favour of regimental Quartermasters, as against the Commissaries proposed by me; and another speaker, followed very much in the same track, assuming that responsibility would be better kept up under the existing system if a connecting link could be introduced between the general and regimental supply. It is with that very object I would attach a Control Officer to a regiment for supply duties. There *is* the missing link. Under the existing system, a regiment is here and Control is there, and there is no connection between the two. An Officer made a remark about the great value of Quartermasters. But I say the Quartermaster would be very much more valuable if he were connected with the general administration of the army instead of being a purely regimental Officer, utterly cut off from general administration. Then something was said about an additional cart for regimental purposes. The question of regimental transport is a very difficult one. On active service and on certain particular occasions, it is indispensable that regiments should have their transport, but, except on those occasions, for the greater part of the time the horses would be eating their heads off, or carrying Officers' private baggage, or doing something that they ought not to be doing, to the detriment of the general transport of the army.

Colonel Fletcher: Only on service.

Mr. Fonblanque: Certainly, only on service and on special and exceptional occasions. Then, it becomes necessary to provide regimental transport, as was the case during the Autumn Manœuvres—I think the Controller at Aldershot is present, and he will correct me if I am wrong—there was one horse and cart additional for carrying implements, not for food; but I do not think you could do that without greatly increasing the already enormous *impedimenta* of our Army.

Colonel Fletcher: It was to bring the food from the depôts to the regiments.

Assistant Controller Crookshank: The carts would be only employed for twenty minutes at a time, and I do not think the Chancellor of the Exchequer would approve of that.

The Chairman: There is a point referred to by one of the speakers with regard to the difficulty that arose from the food-carts and horses of the Military Train being separated. My impression is that the divisions and brigades were so large at Aldershot, so much larger than they are on service, that that might have caused the difficulty. There were thirteen battalions to one division. Thirteen battalions occupy a very large space in line; therefore, I can understand why the horses are sent to one place, in rear of that division, it takes time to get at them; but it is a great object for the Control, whatever name you may give to that Department, that they should have all their horses and men under their own eye, for discipline and for keeping these men and horses in order. This may have been forgotten when complaint is made of separation of the horses from the carts. The carts are brought up to the regiment, and left there, for the men of the battalion to fetch away the food, they have nothing to do with the horses. We may thank Mr. Fonblanque very much for the kindness he has shown in giving us this lecture. It is a question of great detail, and I am sure the lecture and discussion have been very interesting. The more the subject is discussed, the better it will be for the Army.

Evening Meeting.

Monday, March 4th, 1872.

W. STIRLING LACON, Esq., in the Chair.

NAMES OF MEMBERS who joined the Institution between the 20th February and 4th March, 1872.

LIFE.

Pixley, Stewart, Capt., 1st Victoria Rifle Volrs.
Paine, Wm. D., Lieut., 5th Surrey Rifle Volrs.
Notman, H. Wilkes, Capt., Lon. Scottish Rifle Volrs.
Mann, Geo. R., Capt., 1st Middx. Rifle Volrs.
Somervail, Alexander, Capt., 1st. Middx. Rifle Volrs.

ANNUAL.

Vivian, H. H. P., Capt., late 22nd Regt.
Clarke, J. G., Major, late 68th Regt.
Baillie, Wm. H., Capt., late 8th or King's Regt.
Gibson, Edward, Lieut., late S. Gloucester Mil.
Tomlinson, F. P., Lieut., Inns of Court Rifle Volrs.
Leach, E. P., Lieut., Royal Engineers.
Naghten, Arthur R., Major, Hants Art. Mil.
Bevington, Saml. B., Capt., 10th Surrey Rifle Volrs.
Russell, Cecil H., Capt., Inns of Court Rifle Volrs.
Chambers, Arthur W., Capt., 26th Middx. Rifle Volrs.
Chambers, Edward, Lt., Lon. Art. Volrs.
Dixon, Walter C., Lieut., 10th Surrey Rifle Volrs.
Leveson, Edwd. John, Lieut., 5th Kent Art. Volrs.
Hay, H. M., Lieut., Lon. Rifle Brigade Volrs.
Knollys, Henry, Lieut., R.A.
Watts, J. G., Capt., Bombay Staff Corps.
Holland, Stephen T., Ens., 1st Middx. Rifle Volrs.
Farrell, John D. C., Capt., 26th Kent Rifle Volrs.

RIDE-AND-TIE PATROLLING AND SECTION-SKIRMISHING.

By Lieut.-Col. Jones, V.C.

Having been invited by the Council of this Institution to fill up a gap in their Programme of Lectures, &c., I embrace the opportunity thus afforded me of endeavouring to secure ventilation for two proposals, which I have termed "Ride-and-Tie Patrolling, and Section-Skirmishing," by way of expressing the subject of this evening's paper as tersely as possible; and, although my notions may be thought crude and impracticable by some persons, I hope for your indulgence while I do my best to lay them before you, and also for some profitable discussion by any members of the Institution who will kindly take the trouble of refuting or supporting any part of my paper which they may deem worthy of comment.

I need hardly urge, before such an audience as this, the paramount importance of patrolling duties to the safety and success of Armies in the field, more particularly in modern warfare; and it is the well recognised necessity for adopting every expedient calculated to facilitate the performance of those duties which has brought the "ride-and-tie" system to my mind.

"Ride-and-Tie" is, I believe, an old Lancashire expression, denoting the expedient by which two persons get rapidly over the ground with only one horse, by riding and walking alternately, the animal standing or being tied to a rail or gate until the walker arrives at the spot whereon the first rider dismounted for his turn on foot; and, although it may be an extreme way of putting it, this expression so far represents what I wish to bring before you to-night, that it indicates a joint action of small bodies of cavalry and infantry, which has often been employed in war, but hitherto without any previous training in preparation for that intimate association of the two arms in the minor operations of war.

The second part of my subject relates to the fighting of infantry in extended order; and it is my object to show that, by making more use of the "section" than our present skirmishing-drill inculcates, we may, with a given number of men, cover a wider front with more effective fire, and hold the men more in hand for both offensive and defensive action than is possible when the whole are extended in a long line of individual skirmishers.

Without detracting too much from the glory gained by Germany during the late war in France, I believe I may say that the excellence of the Prussian Army in "outpost" and "patrolling duties" was due in no inconsiderable degree to extraordinary deficiency in those particulars on the opposite side, or at any rate that the contrast was thereby thrown more into relief, giving rise to a perhaps exaggerated estimate of the merits of the successful Army; but, after making all due allowance for the deficiencies of her enemy, we must give great credit to the Prussian Army for its uniform success in obtaining good information throughout the campaign.

Perhaps, if we could count upon never meeting a more formidable enemy than the one encountered by the Prussians in 1870, our own light cavalry might be trusted to ride roughshod, as did theirs, over a cowering population, and bring back all required information from a wide range of country; but if we desire to penetrate the secrets of an enemy whose outposts are thoroughly well guarded, whose picquets and patrols are ever alert and ready to capture parties approaching his lines, and whose efforts are supported by inhabitants of the theatre of war, we must find it extremely difficult to obtain the necessary information regarding his designs and movements.

We should not be content, therefore, with rivalling the Prussians in this respect, but should rather try to surpass them by preparing to meet far greater difficulties than they have encountered.

There can surely be no harm in taking a high aim in a matter of such vital importance, and when we clearly recognise the difficulties we are likely to find in our path during the next war, we must be anxious to adopt any plan which may appear well calculated to aid us in overcoming those difficulties.

Patrols formed of infantry, when opposed to an active enemy, would be at the mercy of his cavalry in an open country, and would move so slowly, that they could easily be cut off and captured in an enclosed district; cavalry would do better in open country, but must often be more or less liable to be caught in positions in which it is helpless against a few infantry of the enemy.

Light cavalry are usually employed in small bodies for "patrolling" and "reconnaissance," and I believe there are few Officers of experience in those duties who have not often felt the want of a few good riflemen on foot to dislodge parties of the enemy who, from houses or behind banks and walls, have caused great annoyance to their mounted force.

Such a party of riflemen, judiciously posted behind favourable cover as it advances over the space between our own outposts and those of the enemy, may also very often enable a mounted patrol to advance much further than it would be safe for him to move without the backing up which could thus be afforded; and the check to a pursuing body of the enemy, suddenly encountering the volley firing of these men under cover, would generally ensure the safe retreat of the whole patrol, which might otherwise have been overtaken and destroyed by a superior mounted force.

In order to make the most of such joint action on a small scale between cavalry and infantry,—which joint action is so dependent upon mutual confidence and familiarity with each other's power and modes of action,—I am induced to propose the formation of a "special corps" in which, as a rule, two men shall be assigned to each horse, to work *occasionally* on the principle of "Ride-and-Tie," and always, if possible, to support each other; but the separate action of one man with the horse as cavalry, and of the other as infantry, to be by no means lost sight of in giving this special instruction as to their joint action.

It would be premature to go minutely into the details of organisation before the principle has received some sanction from opinions carrying more weight than my own, and my object to-night is to elicit discussion upon the principle of combining cavalry and infantry in small bodies, in preparation for any occasions on which such united action may be found needful in future wars. I would guard against being supposed to advocate the exclusive use of the "special corps" for the whole duty of the Intelligence Department, and ask your indulgence if, in endeavouring to set forth the advantages of my proposal, I appear to attach undue importance to what can be at best, merely an accessory, additional, aid, under particular circumstances, and not by any means a substitute for the recognised system under which reconnaissance and outpost duties are, and will be, performed by regular infantry and cavalry.

The man intended to be usually mounted should be armed with sword and revolver, and the footman with short rifle and sword bayonet.

The horse could carry a handy spade, saw, and axe, some cartridges for the footman's rifle, and a few discs of gun-cotton, with percussion fuses, besides a very light kit for both men, one cart per squadron bringing up the rest of the men's necessaries.

When the carbine now carried by light cavalry is dispensed with, and a lighter saddle substituted for the one in use at present, I believe that the animal weighted with the above useful articles would nevertheless go into action with less on his back than our light cavalry-horse has now to carry. The greatest possible care should be exercised in the selection and training of these horses, so that they may be trusted to jump ordinary fences, or to stand still while their riders, with or without the assistance of their dismounted comrades, prepare gaps for them to creep over such extraordinary obstacles as may demand a recourse to the tools attached to their saddles.

Whips to hounds, second horsemen, grooms, &c., form the class from which the mounted men should be recruited, while gamekeepers, watchers, shepherds, and detective police would furnish good raw material for the footmen, but the whole force must undergo a careful training so as to develop their individual capabilities.

Education to the extent of reading and writing rapidly, acquaintance with maps and ground shooting, and riding across country, will be required from both classes, although it will be sufficient to demand *excellence* in one of the two latter qualifications from each man of a file, not necessarily from both; nevertheless every man in the corps should be prepared, on an emergency, to shoot fairly with the rifle, or to mount and take care of the horse.

It will, doubtless, occur to many persons that in thus asking for so many qualifications in the same individuals, we may end in getting only smatterers, who would fight badly whether on foot or mounted, and I admit that such would certainly be the case, unless the utmost attention be paid to the selection, promotion, and weeding of this special corps; but so long as the average English gentleman finds time amid a variety of other pursuits, to become a good shot, and to hold his own with hounds, I cannot regard it as impossible to raise a corps of men who can fight "indifferently" on foot or on horse-back, "indifferently" in the strict old sense of that word, which was no doubt present to the mind of Doctor Johnson when he used it to describe the Dragoon of the period.

If love of amusement produces all we require in one class of Englishmen, I cannot see why high and increasing rates of pay, combined with education under the best selected Officers, should not give results with the raw material I propose to draw upon for this special corps.

The best of our police forces and our railway servants have given us good examples of results which may be attained by an increasing scale of pay, in developing special qualities to meet any demand for employments which are somewhat analogous to the one we are now considering; and as the month of annual manœuvres affords the only really good opportunity for training this special corps, I think it will be sufficient to call up the men and horses only on those annual occasions, after giving them some three months' drill on enlistment, and securing their being always forthcoming by keeping a register and holding a monthly muster.

The men might make their own arrangements about horses (of course under the restrictions for satisfying the demands of the service), and a liberal scale of pay would ensure good discipline if full power be given to the immediate Commanding Officer to fine or dismiss without appeal. Employers of labour would in time learn to make arrangements for sparing their men, and take an interest in helping them to gain a pleasant and profitable annual holiday; but of course the success of the plan would entirely depend upon the selection of Officers to carry it out, and on the offer of terms sufficiently liberal to secure competition for enlistment.

If the extreme importance of patrolling and reconnaisance duties be once thoroughly recognised by the public, there will, I think, be little difficulty about high pay for skilled labour, required only during war, and for one month per annum in peace, to the extent of some 400 men and 200 horses, which would go a long way towards supplying our present need; but as regards the former requisite, I confess to the weakness of this as well as every other scheme which hangs upon the selection of the right man for the right place.

It may be objected that the short training on enlistment, and of a month in each year would not be sufficient to make either cavalry or infantry soldiers. But it should be remembered that this corps would not be required to manœuvre in close order by larger bodies than troops and squadrons, and that the education and intelligence of the selected men, put their training upon an altogether different basis from that upon which we have to build up the training of the ordinary recruit. And if the three months' preliminary drill has to be gone through at the volunteer's own expense, on the bare chance of being selected at its close by a number of the corps, that fact will of itself be a great check upon incompetence, while the direct responsibility to public opinion, under which the selection must be made, will generally ensure a right exercise of that power.

The certainty that each one of the members of the proposed corps will be subjected to military and civilian criticism on each day for which he receives pay during the autumn manœuvres should, I think, be a guarantee to the public that its money is not wasted, and the Officer who should undertake the responsibility of the selection and command, would have the very highest motives for guarding against the admission of any but the most efficient and trustworthy members.

The Corps would, in fact, consist of the very cream of the Volunteers of England, and the payment at the discretion of the Commanding Officer, would establish subordination in the highest degree.

I am a great believer in the efficacy of payment by results, and I also consider that the mechanical repetition of parade movements, is not so good a preparation for the special duties of "patrolling" as the ordinary daily avocations of the classes from which I propose to draw the special corps, and, consequently, I should regard the permanent embodiment of such a corps as rather a disadvantage, independently of the additional expense involved in such a measure.

I have little doubt that, when the requirements and corresponding payments became known, Volunteers equal to the occasion would come forward, even if they found it necessary to pass through a short term of service with regular regiments in order to educate themselves up to the required pitch.

There are many occasions in which men on foot, giving their rifles to their mounted comrades and laying hold of the stirrup-leathers, may double their powers of rapid movement for short distances; and there are other opportunities when a few vehicles may be pressed into the service so as to enable the whole special corps to move over greater distances with the rapidity of light cavalry.

The Germans made many rapid movements of the latter kind in France; and in India we have often used camel and bullock-trains to push rifles along with cavalry.

The Franc-Tireurs appear to have driven the Prussians to adopt this expedient, and I have often wondered that it was not more resorted to on both sides in attacking or defending the long line of columns from the frontier to Paris.

In short, the advantages which have repeatedly been derived from combining light cavalry and riflemen for patrolling, reconnoitring, harrassing, or defending lines of communication, are so manifest, even when the two forces have been put hastily together for the nonce, that all nations will, I think, probably train corps beforehand for such joint action in future wars.

The Special Corps would, of course, be placed at the disposal of the Commander of outposts; and, under ordinary circumstances, it would encamp or bivouac by troops or squadrons with the grand guards of a camp furnishing a small party under a non-commissioned Officer, to each of the picquets to act as orderlies, and to assist the Officers thereof in many ways, by giving information derived from a larger observation of the post than that of the daily-relieved picquet. These parties might be relieved at a different hour from that of the picquet-relief, or might be left for several days according to circumstances, and in either case would, I think, contribute to the security and information of the picquet; but neither they nor the main body of the corps should take part in the regular patrolling except under the orders of the Commanders of picquets, whose responsibility must by no means be weakened by reason of this additional aid to their Commands.

In reference to the Commanders of outposts, I may perhaps be allowed to make a digression from my subject, and propose that the Command of outposts should be divided between two Officers, relieving each other daily, one to superintend the picquets, &c., in the field, and the other to be always at the tent or quarters of the Commander-in-Chief. The duties which must be performed in the saddle in effective superintendence of outposts must always be extremely heavy, and a daily relief might be advocated on that account alone; but I would recommend it especially on the ground that the Officer who was yesterday at the outposts and is to-day in hourly communication with them, would be a valuable assistance to the Commander-in-Chief if always at his elbow.

So much depends upon the proper understanding of reports from the outposts, that I do not consider it enough to secure their being quickly focussed at the point whence the orders are to come, unless some Officer be present on the spot to interpret by direct knowledge of the circumstances under which those reports were made.

The duties of reconnaisance and patrolling of the special corps would be directed by the Commander of outposts, both on the march and in camp, in combination with or independently of the picquets; and I cannot but believe that there would be great advantage to the general interests of the Army which possessed such a corps, always ready for enterprizes beyond its line of outposts; nor do I believe that the regular troops would have any ground to complain of such aid in duties which have become so much heavier than they were formerly.

Professional jealousy of volunteer assistance cannot, however, be suffered to stand in the way, if it can be proved that the work may be done more effectually by a special corps than by all the Army in regular turn of duty.

Passing now to the second division of my subject, viz., "Section-Skirmishing," I may remark that the Infantry Field Exercise Book of 1870 has established a far more practical skirmishing-drill than that laid down by previous editions: but there is one reform, only just hinted at, which I have never seen practically carried out, but which I believe to be most important. I allude to skirmishing by sections or groups, *vide* Section 42, Part III of the Book.

When we recollect that cover, such as walls, ditches, undulations of ground, &c., is to be found on ordinary battle-fields, in patches here and there, rather than in continuous parallel lines, it would appear to be desirable to advance or retreat by small detached bodies in single rank rather than by long thin lines extending over the whole front.

With the increased range of modern arms there need be little danger of the enemy slipping through the intervals between these bodies without his sustaining such an oblique fire from the parties under cover right and left of him, as must leave him in evil case to contend with the supports which would move up to meet him in close order.

I should therefore propose that the ordinary word of command for skirmishing should be—Such and such "companies will skirmish by sections at (say 80 to 200) paces."

Supports and reserves to be formed as at present.

Leaders of sections would then have their men more completely in hand, and could be held responsible for due direction of movement, rapidity of rush from cover to cover, and also for husbanding ammunition, a duty which has ten times the importance it held in former days. They should also be authorised to extend their men at any moment when a line of cover, its total absence, or converging fire, renders such extension desirable.

Such a plan as this would, I think, give a unity of action and elasticity of movement, which is wanting in the line of individual skirmishers.

The Captain of each company would superintend his four sections from the rear, naming one of them to direct which is nearest to the company of direction for the Line, and closing or extending his company on any section according to the requirements of the moment.

I should also propose that the non-commissioned Officers and men be permanently assigned to sections, according to the results of musketry course, in order that there may be a due proportion of marksmen and good judges of distance in each section, and that men and their leaders may gain a mutual confidence and knowledge of each other.

The appearance of a well "sized" company on parade might be wisely sacrificed to gain the substantial advantages of efficient command and more effective fire, which latter must result from the arrangement by which the best judges of distance compare notes as to range, and have their conclusions proved by a few trial shots by marksmen.

A section might in this way determine the exact range within a few seconds after each change of position, and the fire of the whole would thus be infinitely more effective than it would have been if each man had to use his own unaided judgment for the adjustment of his sights.

Of course this system is open to the objection that these sections would present large targets for the enemy's fire; but where cover exists, a heavy fire may be supported without much loss, and when once the section-leader has pointed out the next point of cover, there can be no objection to the section opening out for the rush to it across the open. When a line of cover exists, or the total absence of cover makes it necessary to lie down in the open, the section-leader can, as before observed, extend his men at his discretion.

What I want to insist upon is the handling of skirmishers by leaders of small distinct groups, every man of which is well known to them, instead of by extended lines where men are apt to get out of hand and behind or in front of each other, and where the responsibility of section-leaders is less clearly defined. Only let sections (in single rank, of course,) with intervals, be the *normal* formation of skirmishers, to be departed from at any moment at the discretion and on the responsibility of their leaders, but always to be reverted to on the reasons for extension ceasing to exist.

Another advantage of this plan appears to consist in the facility it presents for forming "section" or "company squares" on the sudden approach of cavalry, and yet another in allowing the free movement of and fire of horse-artillery or field-batteries to aid attack of skirmishers from the rear. The action of artillery in support of skirmishers under the existing system must generally be limited to firing at long range from the flanks, because its guns would otherwise be masked by the extended line in front; but if the line of skirmishers be formed of "detached sections," at intervals of 100 paces or so, as a rule, there will be many favourable opportunities for bringing a couple of guns into safe positions whence they may fire through the intervals upon the decisive points marked out for the attack of skirmishers.

Cavalry also may occasionally be brought forward under cover where the ground is favourable to make sorties, and through the intervals, with less danger of destroying the order of the skirmishers than when the gaps have to be made specially for the purpose.

"Tactics," as Napoleon said, "change every ten years" for the advantage of that Army which is first prepared to recognise the necessity of adopting the new system; and, although I cannot go the length of saying, as some writers have lately done, that the day of "lines" and "columns" has passed away, I think we shall do well to prepare for changes in the mode of handling each of the three arms. If those writers are not altogether wrong, the system of fighting battles in "extended-order" is in the ascendent, and therefore I hope that the present is a favourable opportunity for considering whether the system of "skirmishing by sections" would not give a consistence and steadiness to the waving weak line which we now present in extended order to the enemy.

It has hitherto been held that skirmishers should cover an Army as a preliminary measure, and be prepared to fall back when the actual collision of more solid formations is about to take place, but the examples of recent battles tend to show, that attacks may in future often be made successful by re-inforcing, instead of relieving and recalling, skirmishers. We may push our skirmishers forward, and watch our opportunity to reinforce them where weak, or where they appear to be making an impression upon the enemy, and in so doing should be lavish in expenditure, not only of the supports and reserves of skirmishers, but of first and second lines, and even of the general reserve, driving our wedges forward, by successive blows from the rear, and using our "close-order"-formations chiefly while out of very effective range of the enemy.

Instead, therefore, of desiring our skirmishers to look back to their main body, we should train them to watch the movements of the enemy, and to keep pressing on in full confidence that any gaps or weak places will be filled up from the rear.

Before extending I would indicate certain points of attack, and charge the companies on the right and left of those points to keep moving to their front, but to fire as much as possible in converging directions upon those points of attack.

The companies marching upon the selected points would fire direct to their front, and profit by the cross fire by pushing forward as opportunities arise, without regard to exactness of line, so as to seize salient positions.

The supports should be held responsible for really carrying out the duties implied by their name, and would be instantly replaced from the reserve, which would in turn draw upon the first line, &c.

Only make the leader of each body responsible for re-inforcing or replacing the one in front of him as it melts away, and leave the actual collision to the energy and discretion of the company-leaders in front.

Making every allowance for the disparity in point of discipline and steadiness, which was so apparent between the French and German Armies during the late war, something like the mode of fighting above described, does not seem unlikely to prove the change of tactics which may be expected in future wars as the result of recent experience, as shown in the following examples:—

In the attack upon the French right on the Spicheren Heights, at the battle of Forbach, Kameke's entire division became extended as skirmishers, without supports or reserves; and with the aid of a powerful artillery fire from the Galgenburg, held their ground to the end of the battle, contributing most materially to the Prussian success on that day.

Skirmishers and detached company-columns were also exclusively used by Goeben against Faidherbe, and on many other occasions, much after the fashion set in the campaign of 1866, as described in the "Tactical Retrospect."

It is evident, however, that the elasticity and freedom of movement involved in such a mode of fighting must never be suffered to weaken the bonds of discipline, as would be the case if the utmost care be not taken by good Officers to gain and preserve the confidence of their men; for it is sufficiently easy to extend men in an advance, but when a check arises, or retrograde movement becomes necessary, their safety must depend upon the steadiness with which they rally round Company-Officers and Section-leaders, and if these are not in support with their men, the latter should never have been extended. Hence it follows that we should devote the utmost attention to the instruction of our Subaltern and Non-commissioned Officers, if we are to derive the full advantages, and avoid the dangers connected with combat in "extended order."

Our Captains also must be educated in a more independent manner, and taught habits of self-reliance, which are not so incompatible with the most perfect discipline as some persons are apt to imagine; for one who is thoroughly imbued with the true spirit of discipline, and recognises the absolute necessity of obeying and being obeyed (if an Army is not to become simply an armed mob), will submit to his superior, or assume the responsibilities of command with equal cheerfulness; while the unreasoning being who has been cramped by habits of perpetual drudgery on the drill ground, becomes as incapable of independent action and command as the old cavalry troop horse, who snorts and cringes back into the ranks of his squadron when wanted to carry an aide-de-camp or an orderly dragoon. Fortunately, however, the character of the British Officer enables him usually to surmount the obstacles piled up by a long course of "close order" drill whenever an occasion sets him free to exercise his wits in a more independent command, but I am sure there are some of us who have felt the force of the following observations made by poor Rossel in the preface to his "Art de la Guerre." He is referring to the dread of responsibility, and that utter dependence upon their great master, common among the first Napoleon's Generals in the latter part of his career, and which bore fruit in still greater measure among their successors at the head of French Armies in 1870, and he says:—

"Pour oser quelque chose à la guerre il faut être indépendant; com-
"ment accepter une lutte qui toujours a des chances mauvaises s'y l'on
"est accoutumé à s'inspirer de la pensée d'un maître, à s'enorgueillir

" de ses faveurs à s'abimer devant sa colère ? comment s'exposer à une " défaite lorsqu'on n'a pas sa propre conscience pour lui suprême, lorsqu'on " se considère comme puni par une disgrâce comme récompense par un " titre ou un galon ? Le Général qui perd une position, qui laisse " échapper une occasion de vaincre, qui ne profite pas d'un succès, se " retranche derrière la lettre de ses ordres, il a craint de risquer un " revers."

The CHAIRMAN: If any gentleman present is desirous of making any remarks, or to put any questions to the lecturer, we shall be happy to hear him; but what I wish to say applies not only to the present meeting, but to all meetings. The Council are most desirous to organise the discussions, and make them as business-like and to the purpose as possible. They have put up a notice confining each speaker to ten minutes. That, of course, does not apply arbitrarily; but at the end of the ten minutes the Chairman will put himself in the hands of the meeting. If the meeting wishes the gentleman addressing the meeting to continue, well and good; if not, the Chairman will pass on to the next speaker.

Colonel OUVRY, C.B., late 9th Lancers: I think that the proposition which we have just heard from Colonel Jones merits serious consideration—I mean the "ride-and-tie" principle. I think it really very good. We all know that a *reconnaissance en force* is composed of all the branches of the Service, cavalry, infantry, and artillery, and is intended for serious resistance. I do not suppose that Colonel Jones means that the "ride-and-tie" system would be capable of offering any serious resistance; consequently, it would not, in my opinion, be advisable to extend it far beyond the outposts, because it stands to reason that if it were extended to any distance, such as several miles, and were attacked by a superior force of cavalry, the whole must necessarily be overwhelmed. But I think it would be most useful, and far better, when a small force was required, to have the two men and a horse. Of course, there are many minor circumstances which Colonel Jones has touched upon, such as having horses of a peculiar kind, especially broken for the purpose, otherwise they would be liable to fail. But this proposal, although quite new, has been practised among wild eastern tribes. On many occasions they are accustomed to dismount, and, leaving their horses, act on foot. I repeat that I consider the proposal of Colonel Jones is worthy of very serious consideration. As to the second proposition, about "section-skirmishing," I shall leave that to some other gentleman, who is perhaps more conversant with the subject than I am myself.

Sir THOMAS ACLAND, Bart., M.P., Lt.-Col., 1st Devon Rifle Volrs., and Captain Yeomanry Cavalry: I feel that when civilians volunteer to speak on the difficult art of war, soldiers may judge us as we, in our presumption, judge other people when they take farms—we feel that there is only one way to become a farmer, namely, to farm and lose a little money. So soldiers may say to us, "There is only one way of learning soldiering, and that is to fight; lose an arm or a leg, and then you are likely to know something about it." I am glad to be able to shelter myself under the name of so distinguished an Officer as the one who has just sat down, whose works I am sure have penetrated many a civilian's house. I may also shelter myself under the name of a practical Officer, Colonel Bower, who was at the Cape, and who is, what I am not, a very good fox-hunter, with forty or fifty good hunting men attached to his corps at Droxford, in Hampshire. About the same time that his drill-book became known to the public, or a little before, I had the good fortune to make the acquaintance of Colonel Drysdale, of the 9th Lancers, who happened to be quartered in Devonshire at that time. I happened to have the great advantage of having as my Serjeant-Major in the Yeomanry, a regimental Serjeant-Major of the 10th Hussars, and we tried to work out there a system of combining the principles of cavalry and infantry for defensive purposes, because we civilians always thought that we could not be trained for the purpose of attack abroad. Our simple business was to consider how plain men, with good strong arms and legs, with decent horses, with the habit of riding and shooting, could be put in a position where they could best defend their country in case of attack. There were, I think, six corps of mounted Rifles formed in Devonshire in 1859. Some have been changed into what are called "Light Horse," and others are not in a very flourishing position, because the system is not showy, and is not taken up by authority. I hope this excellent lecture of Colonel Jones may lead the authorities really to think about the question, whether one of the regular regiments ought not to be tried, to show on what system a mounted man and a rifle ought to be made convertible on the outskirts of an army. It was tried in America, I understand, with several thousands of mounted men under General Stuart and other Officers, and did great execution. I know General MacMurdo attached very great importance to it, and encouraged us and Colonel Bower to go on; and Colonel Bower developed the system by introducing the extension of fours for skirmishing sections.* I should venture to differ from Colonel Jones on one point. I doubt whether it is quite desirable to have only one horse to two men. I think you had better have one horse to one man, and train your men as mounted infantry rather than as dismounted cavalry. That is what General Douglas advised us to do, on grounds which I would venture respectfully to submit to Colonel Jones. You must bear in mind that in asking volunteers, farmers, and country gentlemen to drill as mounted men, you have to deal not only with untrained men, but, what is a much more difficult matter, with untrained horses. You cannot put a farmer's horse into a riding school. A farmer is essentially a horse breeder. He breeds his horse, he rides his horse, he hunts his horse, with a view to sell him as soon as he gets his price. Then he brings on another horse. Those animals are very awkward under fire, and often awkward to lead or link. What struck us in the Yeomanry was this—we were accustomed, on dismounted service, to these horses in charge of centre of threes. In Devonshire lanes it was useless, if you were to move, to have three horses under one man, and we decided that, if the horses were to be mobile at all, there must be too horses, and not three. That led us to what has been since adopted in the English Army, moving by fours, because we were obliged to go by couples with led horses instead of by threes. I may be allowed to mention another difficulty in the way of Colonel Jones's plan. We had, at first, a certain number of mounted men and a certain number of dismounted men united in the same corps. But the mounted man rides his own horse. The dismounted man is tempted to feel a little humiliated, and he wants to have a horse as well as the other man. We were strongly advised by cavalry men not to attempt the union of the two, though General Douglas advised us to go on with it, but we found it necessary after a time, to drill all alike, and let the whole of the dismounted men get on horseback. My only object in making these remarks is to elicit the opinion of men more competent to deal with these things than I am. I should also like to point out another great difficulty in connection with this subject, namely, the mode of arming such a corps. With cavalry, when you come to deal with this question of dismounted duties, it is very difficult to keep out of this scrape, that you have the wrong arm on the man and the wrong arm on the horse. If the man and the horse part company, and the man leaves his gun on his horse, and carries his sword away with him, that is not exactly the state of things you want. The best solution† I have ever seen of it, but which has never been countenanced by authority in this country, is the arm of the *Cent Gardes* in France, who have a very good short rifle, with a rapier nearly three feet long, used only for pointing, and not for cutting, and which may be fixed as a sword bayonet. Then, if the man is dismounted and has got his sword he is in a position to join in forming rallying square, if he is overtaken by cavalry. Nothing can be worse than for the dismounted man to be overtaken by cavalry, if he has gone away with his sword and left his gun on the horse. I may venture to claim for our little attempt in Devonshire the high authority of Lord Seaton, who was living in Devonshire for several years before his death. He gave us great encouragement to go on, particularly a little corps near Ivy Bridge, commanded by Mr. Yonge, a connection of Captain Yonge of the 52nd regiment. Captain Yonge invented a belt for the men to carry the rifles on their backs; but I do not think it quite answered. Colonel Bower's Numagua bucket seems the best plan. I cannot but feel personally grateful to Colonel Jones for having brought this subject forward to-night, because, although I cannot judge how this system may be used in foreign warfare, it has always appeared to me that in England, where you have so many fox-hunters and good rabbit shots, you want some system to utilise your horse and your gun for defensive purposes. I am afraid we Volunteers cannot give a month's continuous drill, but if you can induce his Royal Highness or the authorities to get a smart cavalry regiment to take up something of this sort, and be trained to it, then you will get the Yeomanry to follow. But you will never get the Yeomanry to condescend to be "dismounted infantry" unless you get a regular regiment to set them the example. I will give a proof of this. Colonel Sir Trevor Wheler, an old Peninsular Officer, trained a corps of Yeomanry in Devonshire called the Royal North Devon Mounted Rifles, in some respects as Colonel Jones would wish. He died, and was succeeded by a cavalry Officer. The formation of Mounted Rifle Volunteers appeared to make the name of Mounted Rifles distasteful, and the regiment has been turned into Hussars, and dressed in imitation of regular Hussars. Unless the Army show us the way, I am afraid the practical solution of the problem before us will never be effected by civilians.

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* Perhaps I may be allowed to add that Lord Eversley invented a skirmishing drill of a similar kind in the Hampshire Yeomanry. The troop was extended by fours, two men of each section of four dismounting.

† I may add that under Colonel MacMurdo's advice we adopted a sword sling of General Stewart's (U. S.), with a hook which could be detached in a moment from the waist belt and hung by a ring on the saddle. I would also suggest that all administrative or rural battalions should be encouraged to enlist four or eight mounted men per company, so that a battalion of eight companies would have 32 or more guides or covering men, who might organise volunteer transport, and be trained to such duties under a special Officer, as Colonel Jones proposes. I have found my mounted men of the greatest use on field days in covering roads, escorting provisions, taking up camping ground, &c. In every district young farmers and butchers could be found for such work.

General VAUGHAN, C.B.: I should like to say a few words with regard to Colonel Jones's second proposition, which I think is most specially valuable. Speaking as an infantry Officer of some experience, I think I may fairly say that in every Officer's experience, it must have occurred to him to observe the great difficulty of handling long lines of light infantry in skirmishing order. In the recent campaigns of 1866 and 1870–71, almost all the successes of the Prussians were achieved I believe, by the adoption of a system very nearly analogous to that which Colonel Jones has so ably advocated. Thus in advancing to attack a position, for instance, the front line, which had originally been a thin line of skirmishers, resolved itself, in consequence of being continually reinforced from the rear and the files composing the different subdivisions drawing together, into a number of detached groups of men, each acting with a common object. Supposing that amongst the minor operations of the war, a village or any defended point was to be assailed by the Prussians, their system in the late war, as explained to me by several of their Officers, was very nearly what Colonel Jones has advocated for adoption in the British Army. The Prussian company is divided, if I am not mistaken, into three subdivisions. The usual practice in such cases was, the point of attack having been first indicated, for these subdivisions to move forward, under the command of their respective subalterns, from one point to another, making a rush forward from time to time, as cover offered, until they arrived eventually within a moderate distance of the point to be immediately assailed; then, the movements of the three were combined, and the three subdivisions would rush forward simultaneously to make the final attack, being further supported by a slanting fire from other divisions or groups, pushed forward to suitable positions. I am quite convinced that unless in the British army some training of this kind is adopted as the practice of the infantry, we shall, in the event of being engaged in a European war, find too late, that our present system of infantry drill places us at a great disadvantage. Skirmishers must be trained, and a suitable formation given them to act as principals, not as subordinates, in battle. Holding this view, I think we cannot be too grateful to Colonel Jones, and to other most intelligent and praiseworthy Officers of the British Army, who are now endeavouring to bring to the notice of the authorities, and to force upon them the necessity of altering our drill, and adapting it a little more to the requirements of modern warfare. Further, I believe, as Colonel Jones incidentally mentioned, that the battles of the two last campaigns have, in all the preliminary portions at any rate, been fought and gained almost entirely, not by the operation of dense columns, or long lines in close order, but by the intelligent and united action of small detached sections, or groups of men. I hope the system will obtain the notice and attention which it deserves from our present Commander-in-Chief; and that he will see fit to institute a system by which troops shall be taught to move in a formation analogous to that which Colonel Jones has so ably put before us, and which is the only suitable formation for the arms, and for the kind of fighting which at the present day has come into vogue. I offer my personal thanks to Colonel Jones for the very pleasant and able way in which he has put this subject before us.

Major Colley, 2nd Queen's: The lecture deals with two distinct points. The first is a system of patrolling, combining the two arms for that duty; the other a question of infantry tactics. As regards the first point, I would rather listen to cavalry Officers on the subject, because it is one upon which they could give the best information. The lecturer is an old cavalry Officer, and therefore speaks with authority. Still, I confess my own personal opinion would be in favour of training the cavalry to perform both duties, rather than combining the two arms. I fear the infantry would hamper the cavalry. We all know that the old system of dragoons, men trained to fight, either on horseback or on foot, has been tried and abandoned. At the same time it should be remembered, that improvements in any art consists in accomplishing what was formerly thought an impossibility. Therefore, the mere fact of its not succeeding hitherto is no sufficient reason why it should not succeed in the future. Another reason for urging it is, that we have to consider what system suits our own special conditions best, not what suits foreign armies. It is quite possible the Prussians may not be able in three years to train their cavalry, to be good cavalry soldiers, and to perform the duty of infantry patrols as well. But we have our cavalry soldiers for six years at least, and at present are not even restricted to the six years. The Prussians succeeded in turning out in three years, cavalry soldiers, who performed all cavalry duties extremely well. Therefore, if we retain our men in the ranks for three, or five, or nine years longer than that, we ought to be able to teach them something additional; and I think that something additional should be to act on foot as well. This has been practised a good deal lately at Aldershot and at other places, but I still think not sufficiently. It has been held that first success in war greatly depends upon introduction and application of new tactics; and I think, whatever army first takes the field with a large force of cavalry trained to act as infantry also, will obtain an enormous advantage. The proposal has been made specially with reference to our Volunteers, but I think it applies more to our regular forces, because for the defence of England we shall always be superior in cavalry. Any force that invades us will probably be weak in cavalry and strong in infantry. Our Volunteers should be sufficient to check the enemy's patrols; and our cavalry ought to be superior to any force that is landed, and able to keep us informed of every movement. The other question discussed in the lecture was that of "section-skirmishing." The lecturer has done very great service in bringing that subject forward, for there is little doubt that our tactics require revision precisely in the direction the lecturer has pointed out. Tactics must always be studied under two aspects, the defensive and the offensive. As regards the defensive, I do not think we require much alteration. Our "line formation" and "shelter-trench-drill" are well suited to defensive action, and ought to enable us to hold our own on the defensive against any troops. As regards the offensive, I fear we are not quite so strong, yet it is this which now requires most study. It is manifest that recent improvements in fire-arms are very much in favour of the defensive, this was universally admitted at first; but after a little while persons began to start theories to show that these improvements have been in favour of the offensive, and several works have been written to prove this. But these theories are hardly borne out by facts. If one goes through the statistics of the losses on both sides during the recent war, one finds that in most of the actions in which the Prussians were on the offensive, they lost nearly twice as many men as the French did, that is, excluding prisoners. On the other hand, in those in which the Prussians were on the defensive, their losses were usually less than one-third of the French losses. That is to say, if one takes the loss actually inflicted on the enemy as the standard of comparison, the result is that the losses on the offensive, as compared with the losses on the defensive, are as 6 or 7 to 1. I think that fairly represents the chances, or I should rather say the difficulties of the offensive, as compared with the defensive. Have we given the former such study as its difficulties require? Some ten years ago I was serving under an Officer who trained us to a system of attack almost identical with that now adopted by the Prussians. We always skirmished. We were trained to attack in skirmishing order, the skirmishers strengthened from the supports, and reserves, if necessary. The point of attack was indicated, and we were trained to charge in loose order, but closing in on the point designated. Each Officer assumed the command of the men immediately in front of him, whether they belonged to his own company or not, and worked with them as a company for the rest of the day. This is almost identical with what is described by the author of the "Tactical Retrospect" as what actually happens in action, and agrees very much with what the Duke of Wurtemburg gives as the result of the most recent Prussian experiences, and if this is what actually occurs in war, it is what men should be trained to in peace. Any one who has watched a line advancing, calculated the number of shots that can be fired at it, before it can come actually into collision, and examined the sort of mark it presents, must have satisfied himself that a line attack cannot succeed against a resolute enemy, armed with breech-loading rifles. The more perfect the formation, the more steady the advance, the better mark it affords to the enemy, and the heavier would be its losses. Ten years ago I came to the conclusion that our line formation, however suited to the defence, was not adapted for offence, and must be abandoned. I have never seen reason to swerve from that opinion, which has been strongly confirmed by recent experiences, and I am happy to think that it is gaining ground now. We must look out for some other system of attack, and here we have the Prussian experiences to guide us. They gained these experiences at the cost of a fearful loss of life. Witness the attack on St. Privat, where they are said to have lost 6,000 men in ten minutes, from adopting too close a formation. It is well for us we have these to guide us, for we cannot afford such losses; had we been drawn into war a few years ago, an adherence to formations of a hundred years back might have cost us an army. The only formation which can succeed in the attack is skirmishing—some system of loose order. Skirmishing means giving each man freedom of individual action. The moment you have individual action, you must subdivide command. As long as 100 men are collected in one company in close order, under the immediate eye and voice of the captain, and only moving by his command, one Officer can command the whole company. But the moment you disperse the men, so that each man must have a certain freedom of action, you must increase the commanders, or you lose all control. You must subdivide the command. The Prussians have aimed at this in their section skirmishing. Their sections do not exactly correspond to ours, as they are independent of the strength of the company, and never exceed 12 men; whereas ours represents a fourth of a company, and might be 20 strong. But the principle is the same; the command is subdivided. They skirmish by sections, that is to say, each man, instead of looking to his captain, looks to the leader of the section, whether Officer or non-commissioned Officer, or only the senior private, and it is the business of the leader of the section to look to the Officer and see that his section conforms to the general movement. It is only by some such system that one man can control a large number, each man at the same time retaining his individual freedom of action. I think, therefore, that the point to be specially studied in our infantry tactics, is *skirmishing* for purposes of attack; and how best to maintain the general command of the captain over his company, by subdividing that command among the subalterns and non-commissioned Officers of the company. One knows under our present system, how the captain is to be seen running from one end of his company to another, thinking it his duty, not to look after the company as a whole, but after each individual man in it. The "section-skirmishing" introduced in the recent drill book, but as yet little put into practice, is a most important step in the right direction, and I think we are greatly indebted to Colonel Jones for calling attention to it at the present time.

The CHAIRMAN: If no other gentleman wishes to ask any question, perhaps Colonel Jones will be kind enough to reply.

Lieutenant-Colonel JONES: I feel very much obliged to the gentlemen who have kindly commented upon the lecture. Colonel Ouvry, I think, quite agrees with my first proposition. I must be allowed to repeat what I intended to convey in the lecture, that I never intended this special corps for distant operations at all, but simply, as Colonel Ouvry wished, for operations not extending far beyond the outposts. Of course, distant operations would require a larger force. But I consider that there are a great many occasions when the commander of the outposts may require sudden information about a particular point in the neighbourhood of the outpost, quite accessible to a small force. But it must be a mixed force—a force accustomed to each other, and able to go to a certain extent with confidence in one another. I may have made too much of the "ride-and-tie system," but yet I think there is something in it in this way. I maintain that cavalry are of no use firing on horseback. It is an utter absurdity for any man on horse to take aim with a rifle. And if he dismounts he is encumbered with a horse that is not steady. Any cavalry horse is apt to be unsteady when dismounted and the bustle of an action is going on; and the fire of his rider is apt to be disarranged thereby. But if the man can ride up to a point and get off his horse, perfectly confident that his horse will stand still, or, can tie him to a rail, he can have time to take his aim; and the man who has been running up can then take his place, and get on his horse, while the other is going on in front; and so relieve one another in certain ways. It is hardly worth while going into details, because I do not suppose the principle is likely to be recognised. But I have an idea that it might be worked out for a small corps. Now, with regard to what Sir Thomas Acland said, I think he went too far in supposing that I intended the Volunteers or Yeomanry, or mounted Volunteers, to be organised upon this principle at all. I must ask you to recollect that my idea was simply, one special corps formed of 400 picked men out of the whole kingdom. I want a *corps d'élite* for this particular purpose; I do not want to get anything approaching regular troops. I want to get men who will compete to get into this *corps*, and who will really be useful men when they are in it, whom you can trust to find their way across country, and in enclosed countries. We do not really recognise the difficulty of getting information in an enclosed country; your cavalry man can ride about in an open country as far as you like, and get information. But if he is in an enclosed country it is uncommonly difficult to get about without being seen. There are cases in which when two men are going together, one man can creep along on foot, where a mounted man, if he went, would expose himself, and would be seen from a distance. All kinds of cases of that sort, I think, may arise in which it may be useful to have this special corps ready to be called forward. I do not simply propose it as a specific for carrying on all the operations of outpost duty, but as a little aid that may be useful in a duty which has become more and more difficult to perform. I believe we have no conception of the difficulties we shall have in a future war, particularly in an enclosed country like England. We have had no experience of it since the Peninsular war. In the Peninsular war, Wellington had a number of old fox-hunters on his staff, who were most efficient in collecting information for him. But I question whether we are as well prepared at this moment to take it up and to get information in that way. I think the information would be more important, and would require to be more rapidly got in these days than it has ever been. Therefore, I think any little additional aid we can get, however expensive it may be (and it is but a small corps we should require), would be worth while to have, making it an object of competition, so that we should get the very best men. In these days of selection, we are trusting to selection for important purposes. I think here we might select the best men in this country for this corps—Volunteers and other men of the kind. General Vaughan, I hope, concurs with me on the second point, and I think Major Colley does also. Major Colley also seemed to imagine that I put more faith in the "ride-and-tie" system than I do. I quite agree with him in all that he said about the expediency of teaching our cavalry to fight on foot. It is very much talked of on the Continent at present; and most nations are paying more attention to dismounted cavalry work than they have done hitherto. I do not at all see, however, that that is incompatible with my having a special corps for a particular little service, in which they may be very useful. I perfectly agree in his remarks about the expediency of teaching cavalry to work well on foot. I am extremely pleased to find that other infantry Officers agree with me in what I said about the captain running vaguely about after his men with a sort of idea that he ought to pull each individual man about, and put him into his place, and the major generally galloping about after the captain. The want of subdivsions has always struck me as a misfortune about our "skirmishing drill." I am very much obliged to you for the attention you have paid to me.

The Chairman: I ask the permission of the meeting to return our best thanks to Colonel Jones for his very interesting paper.

AN OCCASIONAL NOTE ON THE USE OF THE ANEROID-BAROMETER IN SURVEYING.

By Captain R. H. Fawcett, 33rd Regiment, Garrison Instructor, Curragh Camp.

In 1868 a notice appeared in the Journal of the Royal United Service Institution to the effect that brief "occasional notes" from Members serving abroad, on subjects of professional interest were admissible, with the approval of the Committee. I propose to avail myself of this permission with special reference to the use of the aneroid barometer in surveying, as I have been so often asked for simple formulæ and the means of applying them to ascertain heights, that I am sure there is much interest taken in the subject by many who have not had opportunities of investigating the powers of the instrument.

The value of the aneroid as a handy and portable instrument for rapidly obtaining relative heights in surveys, has, I think, been underrated. It is of great value, especially in cases of military surveying, where time is frequently priceless.

The points chiefly valuable in an aneroid are its portability, as in the pocket it takes up no more room than a watch, and the observations and calculations can be done so quickly, that a Staff Officer riding from one hill to another, can easily obtain their relative heights.

In a survey, readings may be noted down in a pocket-book, or even on the margin of the sketch, and calculated out on return at leisure.

When there is plenty of time, and the ground is practicable, levelling or contouring would certainly be adopted in preference; but even then the occasional consultation of the aneroid might be an advantageous check to error. But if pressed for time, or contouring be impracticable or extremely difficult, the aneroid gives heights with sufficient accuracy for ordinary military operations, and is far more accurate than the eye; moreover, the reading may be taken in equal or less time than it would require in most cases to make a good judgment of height.

The simple formula given below may be worked out almost directly on the ground, if necessary.

The best example of the value of the aneroid occurs in a survey I lately made of the Nasciar Lines at Malta, and the range, which by a geological fault, divides the island. Here, on account of the rocky and abrupt nature of the formation, and the way in which every available patch of soil has been terraced for cultivation, it would be a most serious toil at least, to run levels. The aneroid gave me the command of one point over another approximately, with very little trouble. Though it cannot show the height with the accuracy of levelling or contouring, yet its indications may be generally relied on to 10 to 20 feet, according to the care taken, and the number of observations made.

It is of course in abrupt, hilly, and almost mountainous countries, that the aneroid is most useful. For heights of 50 or 60 feet above the plain varying slightly in their relative heights, the reading of the pocket-aneroid might be difficult, and the slightest error important. I have however observations above and below a bridge, the height of which I afterwards measured with a good plumb-line, which show that sufficient accuracy may be obtained with care.

Aneroid observations.		Actual measurement.
1st obs.	2nd obs.	
46 feet.	45 feet.	47 feet.

It almost invariably happens that such small heights can be contoured or levelled quickly, but the case is different with hills of 300 or 400 feet above points in the survey. The contouring of these would take up much time, and the advantage of the aneroid, as far as this reason goes, increases with the height.

The obvious objection to the use of the barometer for ascertaining heights, is the influence of the weather; but this objection seems generally exaggerated. My experience is that, in very stormy, *gusty* weather, the barometer may be influenced so much in the course of a few hours, as to cause uncertainty; yet even in this case, relative heights may be taken, if the points from which the barometric indications are taken, are reached quickly one after the other. A very heavy cloud, that is one on the verge of precipitation into rain, will doubtless have its influence; but, unless a cloud is direct overhead, its influence seems generally gradual, and may be allowed for by returning to some point where the aneroid has been previously consulted, and consulting it again. The mean may be taken, or such allowance made as the duration of time elapsed in passing from one point to the other, warrants. I have done this many and many a time, but found that, as a general rule, the original observations were trustworthy, unless the cloud was dense and directly overhead. It is only in very severe, windy weather, when it is coming on a hurricane, or something like it, that the assistance of the aneroid need be despised; and in this case the prismatic compass itself is almost useless; but, as a rule, very little surveying is done on such days, even in urgent cases; few such days occur in the year at home or abroad.

Most aneroids are compensated for temperature, or should be; the purchaser should particularly make certain of this. Yet, even though it be compensated, it is safer to allow correction for temperature in the case of a survey in hot climates where readings may be taken in the very early morning, and again when the sun has full power.

In reading the indications of the aneroid, the eye is very easily deceived, unless care be taken.

If the aneroid be laid flat on the hand and read, and again held up so that the hand of the instrument shall be parallel to the eyes, there will be found to be a difference.

Again, if it be held *parallel to the eyes* with the higher reading uppermost, the weight of the hand will cause it to read lower than if the position were reversed and the lower reading uppermost. That is, that if the barometer when flat reads 30·10, it may, when held parallel to the eyes and with 28 inches at top, read 30·06, and, when reversed so that 31 inches is uppermost, read 30·04.

The first mode of reading obviously is the most liable to error.

Of the two latter modes it does not matter which is used, provided it is always read the same way. The differences between the readings will be the same. For choice I prefer always to hold it so that the higher number of inches is uppermost. The chief point is to hold it parallel with the eyes; but there is no doubt some fixed rule should obtain with observers.

The mode of using the aneroid for surveying is as follows :—

The reading of the instrument should be taken previous to starting in the place where it is generally kept, or better still from a bench mark (⊼), the exact height of which above the sea, can always be obtained by reference to the Ordnance Survey Department.

On return, the reading should also be carefully noticed at the same place.

If the difference be slight, the mean may be taken as giving the approximate height of the barometer at the time the observations were taken.

For example, if the barometer read—

At starting at 9.30 a.m.		29·50
At top of hill	about 11 a.m	28·92
At bottom of hill		29·42
On return at 1 p.m.		29·60

the barometer has risen on account of weather ·10 or $\frac{1}{10}$th of an inch. Hence the height the barometer would have been at the home station at 11 o'clock (when the hill observations were taken) may be estimated as 29·55.

The observations on the hill, if taken soon after one another, will give the relative heights, if this alone be required, without reference to the weather movements of the barometer. If, however, some time has elapsed between the readings, such reference should always be made, and it is obvious that in all cases such proceeding is the more exact and satisfactory.

Some aneroids have a regular scale attached to them, so that the height may be read off. I have never had an opportunity of fairly testing these; they would evidently be exceedingly valuable where the scale could be thoroughly relied on.

In reading a pocket aneroid there is probability of error; in reading the scale there is a second chance of error, and the calculation is so extremely simple that there is no necessity to run the risk of a double error.

A table is given in "Shifts and Expedients of Camp Life," by W. B. Lord, R.A., and T. Baines, F.R.G.S., from which we can see the movements of the instrument at various heights. From this table I make an extract to give a guide to the difference shown per inch of movement at various heights.

Aneroid barometer reading.	Height in feet.	Taken as inches.	Difference in height per inch.
31·00	0	31	—
29·99	900	30	900
29·01	1,800	29	900
28·02	2,750	28	950
27·01	3,750	27	1,000
25·99	4,800	26	1,050
25·01	5,850	25	1,050
23·97	7,000	24	1,150
22·98	8,150	23	1,150
21·99	9,350	22	1,200
20·97	10,650	21	1,300
19·99	11,950	20	1,350

This shows that a fall of an inch in the aneroid has different values at different heights. But it is only for great heights that there is much difference. The barometer at sea level is generally between 27 and 31 inches, unless a West Indian hurricane is afoot; and for military purposes we do not require to ascertain great heights hurriedly. Therefore the following simple formula will generally suffice:—

Admiral Fitzroy appended to his barometer the rule to add 0·1 for every 100 feet of height. In other words, that the barometer would fall 0·1 for every 100 feet. This was probably intended as a general average to suit different positions. Yet it is sufficiently near the mark that Captain James, R.E., has recommended it for surveying, in the Royal Engineer's Papers, giving as an easy rule that a fall of 1 inch represented a height of 1,000 feet very nearly, when the total relief does not exceed that quantity. This rule is extremely simple, and at the very least would enable a near guess to be made at once as to the command of one point over another with a minimum of calculation. But when the barometer generally stands between 30 and 28 inches, the rule given by Negretti and Zambra is—I have always found—very nearly as simple, and more trustworthy. Divide the difference between the aneroid readings at the lower and upper stations by ·0011, the quotient will give the approximate height in feet.

To put this in a form easily remembered, it is that $\frac{d}{\cdot 0011}$ = height in feet, d being the difference between the two stations.

For example—

At bottom of hill aneroid reads ..	30·38
„ top „ „ ..	30·02
d or difference =	·36

$$\frac{\cdot 36}{\cdot 0011} = \frac{3600}{11} = 327 \text{ feet.}$$

This is, to the best of my knowledge, the most useful formula extant.

It differs from Admiral Fitzroy's formula by giving 909 feet to an inch instead of 1000, and is therefore more likely to be true when the barometer reads above 28 inches. There is a formula to be found in Belleville's "Manual of the Aneroid and Mercurial Barometers," which works out very nearly the same for such cases.

As the sum of the readings of the barometer is to their difference, so is 55,000 (or twice the assumed height of the atmosphere in feet) to the elevation required.

$$S : d : : 55{,}000 : x.$$

But for moderate heights this gives little, if any, advantage in accuracy over the one given by Negretti and Zambra. Many other easy formulæ have been given which have not stood the test.

I have by me some 50 cases in which I have worked out the last formula and the one of Negretti and Zambra's, as well as several others. The result I have found to be that the simpler one is sufficiently close for military purposes, and is most rapidly worked. I have tested them against levelling and bench-marks.

Still even for military purposes of surveying, a closer approximation may often be desirable, and Major Robinson, R.E., who made observations in 1849 (*see* "Aide Memoire Papers," vol. ii, p. 418) found "on "investigation that each instrument should have its own register for "indicating heights from certain peculiarities in their construction." This may be done by taking the instrument to a known height and ascertaining the movement. This should be generally done where accuracy is necessary, and not once, but five or six times; and the mean taken of all the observations which may be taken, to give the amount *that* barometer will rise or fall for the height.

No instruments of the kind, even chronometers, can be made exactly accurate; but if the instrument have a constant rate of error, and this be known, we can attain accuracy for practical purposes.

The best way, then, is to select a day and time, or days and times, when the barometer is not likely to be much influenced by the weather, and by carrying the barometer to two points, the difference in height of which can afterwards be accurately ascertained, the rate at which it moves for every 100 feet can be easily calculated.

It may be noteworthy for Officers who may, in the course of duty, have to go up great heights, that I took an aneroid to Abyssinia, graduated to 25 inches, and that, being at heights much over 5,000 feet, the hand came round to 31 and 30 inches or so for the second time. I thought the aneroid must be thrown out by this, and discontinued observations. On return home, I left it for some time with the makers, but was assured that it had been working correctly, and moreover was told that the difference between 25 and 31 was purposely exactly an inch. I might therefore have gone on with the observations, merely reading 31 as 24, 30 as 23, and so on.

On the other hand, Captain Tupman, R.M.A., informs me that an aneroid in his possession was thrown out of gear, though not seriously, by being taken up a height beyond what it was graduated for.

It may be as well to ascertain this point from the optician at the time of purchase, as well as what the difference given by the instrument for each 100 feet at 30 inches is; but, above all, see that it is compensated for temperature, as most are now.

A large aneroid is more accurate and more easily read than a small one, but it is not so portable. A pocket aneroid can be easily slipped into the coat pocket, and I think this preferable to carrying it in the waistcoat pocket; for the object is to keep it at about the same temperature. In ordinary work, the waistcoat pocket would be the best place, as it is for a watch; but when a man tramps up a steep and high hill he becomes much hotter than he was at the foot; this might affect the aneroid in his waistcoat pocket, but not that in his coat pocket. The small aneroid might enable one to take useful observations in an enemy's country without suspicion.

For the benefit of Officers serving abroad, where books may be inaccessible, I append the formulæ given in "Practical Meteorology," by Dr. Drew, and extracts from his table sufficient to enable them to be worked out. Any one, however, taking up the subject thoroughly, should have that work for reference.

Speaking of the aneroid, Dr. Drew says, "As no correction need be "applied for temperature as regards instrumental variation, a simpler "formula may be adopted than for a barometrical barometer; perhaps "the best is one by Poisson, from which Professor Patton (in the "Journal of the Geographical Society, vol. xxi) has derived the following rule:"—

Multiply the number in the following table opposite to the mean of the temperatures of the air at the two places (in degrees of Fahrenheit) by the difference of their barometrical heights, and divide by their sum.

$x = \frac{d\,\mathrm{T}}{\mathrm{S}}$ where d = difference of barometer readings.
T = number opposite mean temperature.
S = sum of barometer readings.
x = height in feet.

Condensed Table.

At 32° = 52416.
40° = 53348.
50° = 54512.
60° = 55677.
70° = 56842.
80° = 58007.
90° = 59172.

If the number 116 be added or deducted for every degree of the temperature above or below the nearest temperature for which a number is given, then a close approximation is reached.

For example, let temperature at the top of the hill be 48°, and at the foot 56°, then the mean temperature is 52°.

T for 50° = 54512
Add 116 × 2 = 232

T for 52° 54744

Again, if the mean temperature be 57°.

T for 60° = 55677
Deduct 116 × 3 = 348

T for 57° = 55329

The formula and table may be written on a small piece of paper, and gummed on the back of the aneroid.

Dr. Drew gives also other formulæ, but this is the simplest; and, as before mentioned, it is only in the case of a considerable height and some range of temperature, that it is necessary to take the latter into consideration at all.

In conclusion, the aneroid is so peculiarly handy, portable, and adapted for obtaining useful results in military surveys in war, that I consider it would be a great advantage if, in the ordnance survey, some of these instruments might be thoroughly tested with regular levellings, so as to prove their comparative accuracy. From this we might hope to obtain more exact formulæ than we have at present, especially with regard to heights between 100 and 800 or 900 feet.

I have written this in great part for the inexperienced, for I hope to see the aneroid some day in general use with Officers.

Those who wish to go thoroughly into the subject, may get information from—

Practical Meteorology, by Dr. Drew, p. 219 *et seq.*

Aide Memoire, vol. 2, p. 418.

Royal Engineers' Papers, vol. 7, p. 28 *et seq.;* vol. 8, p. 176 *et seq.*

Symon's Meteorological Magazine, June—August, 1866; October, 1867; November and December, 1870; February, 1871.

Shifts and Expedients of Camp Life, &c., by W. B. Lord, R.A., and T. Baines, F.G.S., p. 742 *et seq.*

APPENDIX.

The following is a specimen of the working of an afternoon ride over a survey, to settle some points doubtful and to take in one or two new ones of small importance.

The ride was about 20 miles, but, on account of the difficulties of ground and detours requisite, the points could not be reached so quickly one after another as would be generally possible.

Time, P.M.	Position.	Barometer reading.	Height in feet above sea level by this observation.	By previous observation.	
3.0	At home	29·72	—	—	—
3.15	Pieta (5 ft. above sea level)	29·88	—	—	—
3.30	Bench mark 229 on road..	29·84	46	—	By Ordnance survey afterwards ascertained, 50·258.
3.50	Dome of Musta..........	29·64	232	230	—
4.0	St. Speranza	29·68	195	—	By previous observation, a difference of 50 feet in relative height between S. Speranza and Andrea.
4.15	St. Andrea..............	29·625	248	—	
4.40	Top of Gebel Mir Hanno..	29·58	295	—	—
5.0	Valley at St. Caterina	29·825	73	70	—
5.15	Via Selina and Mellcha ..	29·75	141	137	—
5.45	St. Giovanni	29·80	102	—	—
5.55	Chapel at fork of roads ..	29·75	160	147	—
6.0	Bend of road to P. Camp .	29·79	114	120	—
6.10	Madalena Tower, 5 ft. above sea	29·915	—	—	—
7.0	Pieta, 5 ft. above sea	29·92	—	—	—
7.15	At home (on return)	29·75	—	—	—

Barometer at home 3.0 = 29·72.
Ditto ditto 7.0 = 29·75 between 3 and 7 (4 hours), hence presumable rise through weather = ·03.

Barometer at Pieta (5 ft. above sea) at 3.15 p.m. = 29·880.
Ditto Madalena at 6.10 „ = 29·915.
Ditto Pieta at 7.0 „ = 29·92.
Presumable rise through weather in 4 hours = ·04.

As from the general working of the barometer through the previous part of the day and the condition of the day, there appears no reason to expect any sudden "jump" in the barometer, we may allow for weather a rise of ·01 every hour.

That is, that at 3 p.m. the bar. at 5 ft. above sea would read 29·88
„ 4 p.m. „ „ „ 29·89
„ 5 p.m. „ „ „ 29·90
„ 6 p.m. „ „ „ 29·91
„ 7 p.m. „ „ „ 29·92

Taking these conditions, we proceed to compare them with the readings at different heights at and about the times:—

Bench mark (229) on road at 3.30 p.m. reading 29·84
5 ft. above sea level 3·30 p.m. 29·885.

1st Formula:

Lower station 29·885
Upper ,, 29·840
d or difference = ·045
S or sum = 59·725

$$\frac{d}{\cdot 0011} = \frac{450}{11} = 40{\cdot}9$$

Add 5 feet 5
Height above sea level 45·9.

2nd Formula: S : d : : 55000 : x
59·725 : ·045 : : 55000 : x

$$\frac{55000 \times \cdot 045}{59{\cdot}725} = 41 \text{ feet above Pieta point.}$$

Add 5 feet = 46 feet above sea level.

Height taken as 46 feet.
And so on with each reading.

"THE AUSTRIAN CONFIDENTIAL REPORT AND NEW METHOD OF PROMOTION."

By Lieut. Charles E. H. Vincent, 23rd Royal Welsh Fusiliers.

The subjoined description of the detailed confidential report, which is furnished annually to head-quarters on every Officer in the principal Continental armies, may be found interesting. It is needless for me to remark how invaluable it has proved in the Prussian service. By its agency alone, the right man was always appointed to the right place. The tactical genius found himself brought before the enemy, whilst the more sedentary and inactive talents found ample employment in the difficult task of administrating the civil government of conquered provinces, towns, and villages.

In time of peace a post falls vacant. May be, it requires private means, social qualification, a somewhat peculiar knowledge or temperament. Reference is made to the ledger at head-quarters, and the choice becomes limited to two or three from whom it is not difficult to select. In war, Officers commanding divisions, detached posts, &c., are furnished with a summary of the principal qualifications of each Officer under their command. A "parlémentaire," somebody to examine deserters, to attend on a prisoner of rank, is wanted. The "summary" instantly facilitates the appointment. I will take the Austrian Report as the specimen, entering as it does into the minutest details.

It is written on a printed form at half margin. The questions or points on which information is to be furnished are printed on the left. The information is to be written explicitly, yet concisely, on the right.

Page 1 shows—Corps, name, rank, employment, date of birth, religion, education, place; mode and extent of ditto before entering army. Personal relations before entering service (in any other profession or army). Date and method of entering army. Courses afterwards passed through. Private relations (married, single, or a widower, children, independent means). Medals or decorations.

Page 2—Promoted, transferred, passed over, &c. Length of service absolutely with corps.

Page 3—How been employed to be given year by year (if the Officer has been employed in various ways to be shown thus) :—1868, January to June, Acting Adjutant; 1868, June to December, Comptroller duty; 1869, January to March, Aide-de-Camp; 1869, March to October, Musketry Instructor.

Page 4—Campaigns, wounds, services in the field.

Page 5—Special services. Special and peculiar abilities, painting, gymnastics, swimming, drawing.

Page 6—Year to which Report refers. Present employment, knowledge of languages (whether slightly or thoroughly). Capabilities in matters connected with military duty (riding, judgment in horseflesh, training of recruits, &c.). Capabilities in matters unconnected with military duty. Zeal, success, ambition, thirst for knowledge. Conduct and character before the enemy, on service in peace, in private life. State of health, fitness for a campaign. Special remarks. Claim for promotion. Remarks by Inspecting General.

As the General's report checks that of the Commanding Officers, it is difficult for the latter to show pique or favoritism. I will but add one word on the new law for promotion in the Austrian Service (March 14, 1871).

Promotion goes by seniority or non-seniority. Those who elect for the more rapid advancement of the latter method, which is open to all, have to pass a very severe practical and theoretical examination. They are then promoted in numerical order on the list of successful candidates. Every sixth step below field rank, and every fourth above it, is given to a non-seniority candidate. Promotion goes right through the Army, arm by arm. In all cases, Captains have to submit to a very severe practical and theoretical test before they are promoted; to prepare for which, it is optional with them to study for eleven months at a special school, and all promotion depends on "thorough fitness." The Staff is organised much on the model of our own, but "mathematics" form no part of the entrance examination to the Staff College, or of the course of instruction there, while civil administration, the exact topography and military power of every European State are the objects of unceasing study.

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LECTURE.

Friday, March 22nd.

Lieutenant-General the Hon. Sir JAMES LINDSAY, K.C.M.G., Inspector-General of Reserve Forces, and Vice-Chairman of the Council, in the Chair.

"THE STRATEGY OF INVASION, AS EXEMPLIFIED IN THE AMERICAN AND AUSTRO-PRUSSIAN WARS, AND IN THE WAR OF METZ; WITH REMARKS ON CENTRES OF DEFENCE AND THE TRAINING OF NATIONAL FORCES."

By Colonel Sir R. A. Shafto Adair, Bart., F.R.S., A.D.C. to the Queen.

The Chairman: Sir Shafto Adair, requires no introduction to the members of this Institution. The Institution has so often benefited by the lectures which he has given, as well as by the models which he has presented to the Museum, that I pay him the compliment of saying that no introduction from me is necessary. He has distinguished himself as a writer, as a modeller, and as a lecturer, and the army has benefited by the service which he has rendered to this Institution. I have, therefore, great pleasure in asking Sir Shafto Adair to come forward and give us his lecture.

Sir Shafto Adair: It is my first and pleasant duty to express the thanks that I owe to the Council for their consideration in having allowed me to postpone the lecture which I am permitted to give this day. It is a lecture on a subject, as I venture to think, of exceeding importance; one that has assumed a prominence as the social question of our day since I last had the honour of addressing you in this theatre.

The question which I propose to treat, is the "strategy of invasion," and in some degree to endeavour to gauge what may be called the processes of national thought that lead to invasion, and the means of resisting and of consolidating the national forces against it. For though the nation is unfortunate indeed, that is always preparing for war, that nation must be still more miserable that is not prepared for war when it comes. I speak of the "strategy of invasion," and here, though a definition is proverbially dangerous, I would endeavour to express the force that the word strategy conveys to my mind. There has been, I venture to think, without presuming to say that I shall accomplish the solution, a great confusion made between strategy and tactics. To place the matter before you, I would say that by strategy I understand that preparation for war which makes the success of given movements probable; and tactics to be that preparation which makes them possible. We have seen instances in which high strategic talent may not be connected with the means of carrying strategic movements into effect for want of tactical development in the troops that are employed. On the other hand, a highly elaborated tactical system may not give occasion, or not find employment, for great strategic skill. It appears to me that such is the better way of investigating this question, inasmuch as the idea of invasion, a novel one to a great extent in the forms in which it has been lately made evident in Europe and in America, should be investigated and sounded to its depths. Invasion means a war of a decisive and severe character. Invasion means a war not merely to occupy military posts, or islands, or to divert the course of commerce; but, as we have seen it exemplified in later years, it means that effort of armed force which shall substitute entirely one system of government and ideas for another; or, shall leave the vanquished party so helpless that for years to come it may probably be unable to emerge from the state of humiliation and defeat in which it has been left at the close of the contest.

In reviewing this question, the chief and most prominent agent in the late European wars of invasion is that mass of armed force which is now consolidated under the name of the German Empire, which has been developed on the nucleus of the Prussian monarchy. It may appear strange, but it is clearly to be proved and traced, that the idea of the unification of the German Empire lay at the bottom of all the wars that we have seen on that account of later years. To reduce the question to a simple expression of formula—from Jena to Sadowa, from Sadowa to Sedan was one unbroken continuous line of action. In 1813 the Prussians with a noble courage, recovering from their utter humiliation and defeat, joined eastern Europe in an attack on the French Empire. From 1813 to 1815—16—17, their period of supremacy was unchecked in the occupation of France. Then, I make no doubt that the pressure of French conquest which had held down Germany, generated a craving for German unification, of which Prussian policy became the exponent in the institution of the Zollverein, and has been finally the armed apostle at Sedan. For it will be remarked, that in 1818, the Prussians commenced that course of consolidation by their custom-houses, which they have now welded together by their arms. And in this course of unification necessarily, such a supremacy would probably be challenged, and such has proved to be the case, by the hereditary opponent of the Prussian Monarchy, the Emperor of Austria. Thus, then, the campaign of which the first period terminated at Königgratz, and closed at Blumenau, was forced, as it were, upon these two great empires by that fixed determination of the German-speaking race to be one people, which had been shown to a slight extent on the dismemberment of Denmark, and received its full development after the defeat of the Austrian Armies.

So, then, we have to consider whether this idea be not of so intense a description as to give a new feature to war; if, in fact, it be not true that the armies of even the eighteenth century are of power inadequate for the demands that are now made upon military resources, in order to gratify desires which are wide as the national impulses. From this point of view it will be seen how wise and sagacious, as well as effective, the Prussian arrangements and preparations have been.

Prepared for war at a moment's notice, with enemies in front, in flank, and in rear, as soon as the hour sounded had struck, Prussia hesitated not for one moment to strike quickly and strongly. And there is a simplicity with respect to the Prussian movements which will dispense with my directing your attention on successive points, to show how the tide of battle ebbed and flowed; for when the quadruple arrangements of the Prussian armies are once detailed, the army of the Main on the proper right of the army of the Elbe, and of the first and second army, and, as will be familiar to you all, the objective point of Vienna in the distance, the whole plan of the campaign of Sadowa lies before you.

I would here request your indulgence for a moment to say, that I do not propose to enter upon the movements that have decided battles. Other writers and speakers have dilated upon them; indeed, the time would fail me if I were to attempt to pause upon many a noble movement, upon many a feat of arms. I propose simply to indicate the detailed movements of the armies, and to enquire how far these are consistent with the principle which I have to lay down, that every nation must have its centres of defence, and that that nation is most fortunate in its preparations for defence which is so constituted, geographically, that the lines of hostile approach must be known. On this I shall have to speak more at large when I come to the defence of our own shores.

Thus, then, with sudden surprise, the Prussians broke up from Berlin, leaving to the army of the right-flank the care of the outlying Hanoverians and Bavarians, and pressed forward with a boldness which might almost be considered rashness, if they had not been perfectly confident of their own resources and power of reparation in losses or defeat. They could not have known of the resistance they were likely to encounter, or how far it would fail the Austrians, like the broken reed, when the hour of struggle came, as it did in too many instances. This they could not have known, but confident in their own strength they pressed forward, and after subjecting themselves to the chance of considerable reverses, with the objective point of Vienna before them, the great fight at Königgratz or Sadowa was fought, which is the term of the ascendancy of the Prussians in the Germanic empire. I propose before I leave this subject to remark generally upon the military advantages which the Prussian system presents. But at this juncture one magnificent strategical movement or inspiration seems to have waited on Prince Frederick Charles, the Commander of the first corps. He guessed, though he did not know, where the Austrian troops would probably meet him. He requested that the King (now the Emperor) would order that flank movement of the Crown Prince which decided the battle of Sadowa. As regards the mere matter of mere fighting, I am inclined to think that the battle of Sadowa or Königgratz proved not much more than the desperate courage of the soldiers on each side. It was a battle of parallel lines; it was a battle of hard fighting, until the moment came when the fresh troops of the Crown Prince drove the Austrians in retreat upon their fortresses, and would have utterly demoralised that army, failing the courage and self-sacrifice of that column of cuirassiers, which led by an English soldier covered the retreat of the Austrians on that disastrous day. I know that soldier well. He went down into that battle with his column of cuirassiers as if he had been a child born of the country as he was a soldier sworn to her standards. He was left on that field, but has recovered to lead hereafter, I trust, the Austrian armies whenever he may be required.

Then came the movement on Frohsdorf. Here, with regard to the strategy of invasion, and the resolute countenance of either army in these fights, it was a question, it might have been a question, whether the war would conclude. It may be thought that under ordinary circumstances the war would not have been concluded. But there was Hungary doubtful, there was Italy always threatening. But, on the other hand, there was the Entrenchment of the Frohsdorf, which it would cost much to reduce, as may be learned by a plan drawn by an Officer of the Royal Artillery, Mr. Nolan. More than that, there was yet time to the Austrian empire; and if it had been worth while to sacrifice the capital, to pass to the ridges in rear of the Carpathian mountains, and there to consolidate and prepare a further defence, covering the front with heavy masses of field artillery and light cavalry —in which the Austrians generally were so superior, although not successfully handled in this campaign—and then bringing up every man and horse even from the distant Turkish frontier, then, if it had been worth while, a campaign in Moravia and Silesia might have ended in planting the Austrian eagle in Berlin. But in this case Austrian victory was neither looked for nor anticipated. In the judgment of the Austrian Government, no such contest at that time was possible. Austria abandoned her place of pre-eminence in Germany, and it was filled, as of right, by her conqueror.

Sadowa led to Sedan. It was well known how a jealousy of lost power and military credit rankled in the French heart and precipitated the war of Metz. It has always appeared to me that it is well to stamp a war or campaign by the most prominent incident during its progress. The siege of Metz, or rather the investment of Metz, was the turning point of that campaign in France. But when we consider this war of invasion it must have struck you how very different the line of invasion of France was from that followed on any former occasion. The line of invasion in the great war of the Republic during the time of the Convention was principally on the north-western frontier of Germany or from the direction of Austrian-Flanders, and thence passing eastward as far as the passes of the Argonne, in Champagne. The French

Emperor had now the opportunity of selecting his line of advance and determining its direction. I have often wondered wherefore he adopted that special line of entrance into Germany. It was avowedly a portion of the Imperial policy to operate upon the probably discontented populations of the Main, and so to make friends and allies in southern Germany. It may have been that for reasons of military expediency he wished to have a fortress to rest upon; but whatever those reasons may have been, the campaign now begun, was virtually lost so soon as the French Armies deliberately rested on their mass of fortresses and on neutral territory. For it is most striking, that in this campaign, one of the oldest and most honoured maxims of war, on the small scale at all events, and I think on the large scale, has utterly shown to be inapplicable. We know that to have a flank "*en l'air*" is notably an exceedingly dangerous position, whereas to have a "supported" flank or "*en appui*" gives confidence and consistency to an advance or security to your defence. But here the protected flank was the dangerous one; and at an early period of the campaign, if the French Armies had fallen back leaving a clear flank of action on their left as they had on their right, it would not have been possible to have brought them into helpless masses, jammed up as they were against an impassable frontier. No doubt the Prussians saw their advantage in that respect; for it seems to me there was the tendency in the Prussian movement always to keep the left shoulder forward, and gradually to drive the French past fortress after fortress and battle-field, till at last, which could scarcely have been anticipated, the "*impasse*" of Sedan forbidding further retreat, closed the first act of the war, and left the Emperor and his armies prisoners. Yet the Prussian strategist could never have anticipated such a sudden termination to the resisting power of the French regular armies.

No doubt it was in his mind, it is probable as an alternative, that one great battle would have been fought at Chalons. Chalons had been selected for the practice camp of the French armies during many military seasons. It is eminently adapted for the defence of the capital. And here I would remark upon the difference between the mode of defence adopted in the late French campaign, and in that glorious campaign of 1813, when the great Napoleon kept three armies at bay in the open country. His flanks were unsupported, and he shifted his flanks so that they became fronts, and drove the enemy, as long as material force lasted, from the road to Paris. The accounts of the battles of Champaubert, la Fere Champenoise, and other battles in Champagne, show with what activity and success he manœuvred. It will be remarked also that the only point at which the late French line of defence touched the French line of 1813 was at Laon. At Laon, in both cases, a combat ensued. But in 1813 it was a combat on the way to Paris, and was won with difficulty after the great fight of the plateau of Craonne. The original line of defence as shown in the maps on the wall is the lower line, which is not marked by flags, but simply by these discs showing the way to Paris. Still I cannot suppose the Prussians, in the first instance, anticipated that thus the objective point, Paris, would be reached at last, and the sub-objective points, Metz and other fortresses, be masked, and observed eventually to surrender.

Now, Paris had been fortified with care many years previously. It had been fortified, it would appear, with a double motive, against internal insurrection as well as against a coming emergency. Those who are acquainted with Paris, those even who look at this model on the table, will concur in opinion, that the defence of Paris, from a military point of view, is shorn of more than half its value; that, in effect, the forts furnish facilities to siege operations, and to attacks which materially impede their uses. In place of dominating the country, they dominate the capital. Any works that are brought in attack against these forts, are brought in attack also against the city that lies below. There is scarcely one of them so well advanced on the outer country as to prevent an enemy seeing to the reverse slopes; that is the great principle on which towns should be protected by works; and it is on that principle that I maintain now, as I have always maintained, that London is the most defensible capital in Europe. It was a matter of surprise, I make no doubt, that Paris was invested and not besieged, for there are so many points of attack from which decisive speedy results would have been obtained, that if it had consisted with the Prussian system such, doubtless, would have been the application of siege power. For instance, the weakest point of Paris is on the peninsula of Charenton. Forcing siege approaches in the throat of that peninsula, and turning a double line of attack right and left, fortress after fortress would lend itself an easy prey, each affording lodgments in succession for the capture of the next; and once in possession of these heights, the enceinte of Paris is perfectly worthless. It is a polygon of long faces that are a provocation to enfilade fire. The bastions have scarcely a point of flanking fire; and from their very long reach and stretch, they would be utterly untenable by troops holding the lines.

But here let us begin to do justice. With this difficult fortress to maintain; with a population whom no one could trust or credit with the possession or practice of the qualities of resistance and endurance; the armies of France dissipated; her Generals on parole; there were found men who did not despair of France, and who maintained a resistance, which, however it may be discredited, was noble and patriotic in the extreme, so long as the chance of assistance or relief from the country had not failed them. Men talk of Trochu as a dreamer and enthusiast, but he had the noble enthusiasm that acts on the hearts and spirits of men. And when we come to consider more closely the conditions under which Paris was held, it will be said that to Trochu and the soldiers of Paris, and, above all, to those *gardes mobiles* who showed, as Frenchmen, a spirit worthy of their sires, that honour should be given.

And now one of the natural lines of defence comes into play, the line of the Loire. It has always been the tradition of the French armies to retreat on the Loire. Napoleon, after Fontainebleau sent his armies to the Loire. Behind the Loire was power of resistance sufficient, if other circumstances had been favourable, to have enabled the

French Generals to concentrate their troops. It was otherwise. Chanzey and his bravery, and the sacrifice of hundreds of thousands of lives of young Frenchmen; the splendid manœuvring of Faidherbe in the north-west; the desperate flank movement of Bourbaki to the east in the endeavour to enter Germany, were all lost; and Prussian endurance was rewarded, and justly rewarded, by the subjection of France itself.

Now, I speak of what the Prussian merit consisted in. To my mind the first is the great tactical merit of *continuity.* To put the matter in a not exaggerated shape, it would have been perfectly possible during the war for the Prussian soldier with his *feuille de route*, to pass from Lubeck on the Baltic, to Rouen on the Seine, and to report himself every day to a Prussian detachment. It is that marvellous continuity which permits of no break, which brings forward not only the fighting man but the stores and the ammunition, which makes the fighting man available, which, above all—and I believe there is much in this—connects the man with his country, so that the landwehr sentry watching before Strasbourg, felt that there was a continuous electric chain between him and his household in Pomerania; it is this which I hold to be the prominent advantage of the Prussian system. It may be questioned, and I do question, whether this tactical rigidity is altogether the best for soldiery, general, or armies. Tactical rigidity was not that power which won the battles of the peninsula. Tactical rigidity is not that faculty which won the battles of India. Tactical rigidity is not that force which cleared the Caucasus, that wonderful effort of Russian soldiers. It was the pliability, the elasticity, the making the most of circumstances, never being discouraged, and not being compelled to have the machine in the most perfect order that it might work at all, that has given an advantage to the elastic system. But the Prussian system has done its work, and done it well.

On three points we are indebted to Prussia for material improvement. The Prussians discovered, and with a happy result, the means of defending the salient of a bastion. The Prussian casemated mortar battery is one of the most ingenious applications of artillery fire to the defence of the weak point of fortifications. The Prussians also developed the polygonal system under which Todleben so defended Sebastopol. They have also organised in this system a mode of defence suitable to their Volunteers; for their Landwehr are to a great extent equivalent to Volunteers. A Prussian fortress is always accommodated with large *places d'armes*, wide ditches, and ramps of easy access, the object being to precipitate the garrison into the country; and for these three additions to military science, Europe is indebted to the Prussian school.

Time does not permit me to go further, therefore I will now pass to a war of stupendous area, a war of unanticipated duration, a war than the results of which, none have been more conclusive. I speak of the war between the Federal and Confederate Governments of North America. We are indebted to an Officer of the Household Brigade, Colonel Fletcher, for three volumes on the great war of the United States. I may say that the fluctuating fortunes of that fight are described with a clearness that only requires time to appreciate and to master in detail. The work is illustrated by maps, which give precisely what a military map requires, that is to say, the points of movement and the point of attack, the main features of ground, and nothing more. The growth of this war is very remarkable. From 70,000 men, which was esteemed sufficient in the beginning of 1861, the demands rose in 1862 to 663,000 troops on the part of the Federal Government alone. The war was then spreading in every direction, and from the circumstances of the country it required that elasticity which I have already insisted on as essential to great military systems both by land and sea.

I hardly know how to bring the conditions of this war more clearly before your minds perhaps than by this. Think of a great country, bounded by the Atlantic on its extreme eastern coast, and by great rivers to the westward; inhabited by a population of resolute, determined men, men accustomed to the hard active warfare of life with head and hand, and this country to a great extent still covered with the primeval forest. Think that the two portions of this great country are arrayed against each other, and that the line of battle is limited to a comparatively narrow portion, of which one side shall be formed by the Ohio and the Mississippi, another by the sea, and that the northern boundary is divided, not unequally, by the far stretching chain of mountains which, rising in Vermont, pass downwards to the plain of Georgia. You will then imagine two capitals, the objective points of attack respectively: Washington, the capital of the Federals, Richmond, that of the Confederates. You will see that these points of attack are so near in connection, that it is marvellous one or the other should not have succumbed in the first campaign. From Washington to Richmond in an air line is but 110 miles, and yet it took more than five years to cross that interval to the destruction of the Confederate power and of the Confederate Government sitting at Richmond. This peculiar conformation of the country, naturally suggested first movements principally influenced and controlled by the rivers, which between Richmond and Washington, run in parallel lines. To the north of Washington were mountains dividing Virginia from Kentucky and Tennessee, through which the great strategical movements of most of the campaigns were effected. Beyond, to the west and southward, spread the Mississippi, the Ohio, the Tennessee, and the Alabama and other rivers, all capable of floating navies, and of course therefore largely adopted into the system of warfare. Then came the war beyond the Mississippi, which, however, was desultory, and never led to any great results.

It was felt by McClellan, the first distinguished General of the Federal forces, that on this great service, and with such means of resistance, novel plans of operation were imperative; and this was his plan. He proposed to drive the enemy out of Virginia, and to occupy Richmond, Charleston, Savannah, Montgomery, Pensacola, and New Orleans; in other words, to move into the centre of the enemy's country, and crush out the rebellion. This was the way he proposed to crush out the rebellion in six of the most powerful and warlike States of the Confederates. Then, to pass up these great rivers, studded as they might be with material impediments, and bristling with the enemy's riflemen, with a determination to make effectual what has been called in America the anaconda plan; that is the plan of constriction, as the boa constrictor compresses the wild animal. And by the indomitable spirit and inexhaustible resources of the Northern States, this plan was completed to the destruction of the Confederate Government.

I have taken some pains to form a list of the battles; but in the multiplicity of actions it is impracticable to dwell upon them. In five years of fighting there were 46 battles, many of them of two, three, and four days' duration, and one, the great battle of Richmond, of seven days. There were twenty-four combats, by which I distinguish those actions which are smaller in numerical force of combatants, and in the results, than the great battles. There were twelve naval expeditions. There were forty-two military expeditions in force, commanded by general Officers, acting for strategic purposes. There were twenty-two forts captured and twenty-four cities occupied. These are some of the results, and if time were afforded to detail the incidents of these movements, the interest would be well justified. But perhaps the greatest action of the war was that of Chancellorsville, fought by the Confederates under that remarkable soldier, Lee, supported by Stonewall Jackson. And there strategical and tactical power were strikingly exemplified. Lee massed his inferior forces—inferior in number—on the proper right of the Federals. He passed a whole Army Corps to the rear of their right; he passed them without being seen, or if seen, without being suspected, and thus engaged, and won that great battle, about which, after all, like most of the American battles, the faithful historian reports in a single word, "indecisive." It seems that the strategical talent which was shown by Lee, and especially by Jackson, in the campaign of the Shenandoah valley, by Burnside on the Federal side, and by other Generals, was sufficient to bring the troops up to the point of attack, but after arriving there the struggle was left to a great extent to the soldiers themselves. A great deal, of course, may be attributed to the nature of the country. And it is constantly remarked by the historian that the Generals were almost unaided, in the first parts of the war, at all events, by the assistance of the Staff, which is so necessary for securing the execution of orders, even for brigade or division, on a field day. Then, the country, being dense with forest, originated and made necessary one novel mode of conflict. Lines were formed, troops advanced, one mass of fire overpowered the other, retreat ensued, and was but seldom consummated into rout, for the cavalry were not sufficiently trained for this purpose, nor were the troops held in reserve sufficient to make the rout effectual. Consequently, even after such actions as Antietam, which relieved the Western States, as those of Cedar Mountain and the Blue Ridge did the Eastern, a decisive result was but very rarely attained.

But the difficulty of the country generally brings into play a remarkable quality of the Federal and Confederate troops, namely, the habit of entrenching. General Grant's plan was to entrench, and then move forward from either or from both flanks. If repulsed, the epaulement which had covered the troops received them again to shelter. If successful, he advanced and entrenched again. In the twenty-five miles traversed by the troops after the defeat at Shiloh, or Pittsburgh-Landing, they entrenched seven times. Such work has never been done by any army in the world since the Romans pitched their camps in this country. And the mode of entrenchment is suited to the character of the troops. As the regiments halt in line, arms are piled, and from each company working parties of twelve or fifteen artificers, with spade, and pick, and axe, are detached to the front. In forty minutes an epaulement proof against musket shot is thrown up, and in two hours a field rampart, proof against field artillery. The troops of either army entrenched in the morning, and again in the afternoon. Then came out the sterling character of the soldier, showing what manner of men these were—peaceful men, brought from every region of the United States, but, alas! for the purpose of fratricidal combat. The cavalry of the Confederates was at first of exceeding excellence for partizan warfare, though I can remember but one instance of a charge in mass. But, again, mark the enduring spirit of the North. Gradually the cavalry of the north combatted on equal terms, and the raids of the Northern troops were carried as far within the Southern lines as Richmond, just as the partizan leader, Morgan, had harassed Washington and passed round into Pennsylvania. Deeds of brave soldiers, there were many; movements of scientific Generals, there were many; tactical achievements, there were few or none.

Now I pass to the Navy; and here the qualities of the national character were developed with skill and intensity throughout the whole line of the American coast. There are some portions of the history of the sieges on the coast which will bear comparison with any in our European history. For instance, the bombardment of Fort Wagner, and the unfaltering endurance of the troops who carried on those approaches, stand side by side, and without disparagement, to the great valour and constancy of the artillery who held the Chofre batteries before San Sebastian. Higher praise, in my opinion, there is none to give.

And so the war passed on, and I find that I must even abbreviate much that I intended to say. But as a supplement to my opinions and theories, let me read to you what the American armies of the North effected in their organisation. I hold in my hand the return of the Quartermaster-General's department in the last year of the war, giving a complete account of the state in which the war had left the Federal war department; the stores and supplies. He says "the transport "fleet exceeded a thousand vessels, of every variety of construction, "impelled by sail or steam."

We have heard of the destruction of the railways, this is what the repairing corps did:—

"The Etowah bridge, 625 feet long, 75 feet high, was burned by "the rebels, and was rebuilt by the labour of 600 men of the construction corps in six days. The Chattahoochie bridge, six miles from "Atlanta, is 740 feet long, and 90 feet high, and was built in 4½ days "by 600 men of the construction corps."

That shows how effectual their organisation was. The Report says:—

"The close of hostilities made even greater exertions on the part of "this department necessary; 233,000 men were distributed from "Washington alone to their homes in the north, carried to every "hamlet and village, camps of discharge being established in every "state at which the regiments rendezvoused until paid off, when the "men dispersed. 60,000 men of the army of General Sherman were "moved from Washington to Louisville, from which place, after a "short time, they were put in motion for their homes, and discharged. "25,000 men were moved from the James river to the Rio Grande. "7,000 men were sent from the Potomac to Savannah. 60,000 "prisoners of war, released, were sent to their homes in the Southern "States."

The purchases were enormous. The purchases of cavalry horses during the year ending June 30th, 1865, are reported to the number of 141,632. Of artillery horses from September 1, 1864, to June 30, 1865, 20,714. These show the vast proportions of the organisation of this army.

With regard to the army that was formed by General Sherman, and that advanced through Georgia, and determined the struggle at Savannah, this is reported:—"This army of 100,000 men needed to be "entirely re-clad and re-shod, the troops were to be fed while resting, "for as soon as the army ceased its march, it ceased to supply itself by "foraging, and depended upon the supplies from the coast." This is on the 25th of March. "Nevertheless on the 7th April I was able to "inform General Sherman that the necessary supplies were in his "camps."

With regard to the transport fleet there were in the last year, 719 vessels of 224,984 tons assembled. The movements of railroad transportation were most remarkable. The entire command, which was ordered from North Carolina to co-operate with General Sherman, "including a brigade of artillery and the seventh division of the cavalry "corps, was embarked on the fleet. It consisted of 17,314 men, 1,038 "horses, 2,371 mules, 351 waggons, 83 ambulances. The embarkation "began on the 5th February, 1865, and was completed on the 8th. "The fleet sailed on the 9th, and the command arrived at New Orleans "on the 23rd, having been moved in 13 days 1,330 miles."

Said I not well that a nation is unfortunate that is not always prepared for war, though it may not be disposed to seek war? Consider and ponder what was done by that American expedition.

Then, with regard to the engineers, we must fairly consider in a period of peace what our nation and other nations are doing. This is very striking to me in the American system, that it is so elastic, and brings evidently talent of every description into its service, and utilises it to the highest point Now with regard to the corps of engineers. There are only 106 commissioned engineers drawing pay as United States' Officers, and during the year 1870 appropriations were made for sixty forts on the Atlantic coast, for four forts on the northern frontier of the States, for fifteen batteries on the Atlantic coast, for three forts on the Pacific coast, and five batteries for San Francisco and its dependencies. And not content with these warlike appliances for the protection of the country, sixty-three special surveys are appointed for the great rivers and falls of the United States. Great as that country has been in the past, great as it has been in peace, I think we may say, it shows a stupendous aptitude for the struggles of war.

And yet I am not one of those who are inclined to believe in the invasion of Canada. Measuring forces, I believe Canada to be perfectly defensible so long as the people of Canada are determined in their defence. I believe Hamilton and London, Montreal and Quebec, and the lines of the lakes, with the facilities which they give us for bases of operations, with a population armed and earnest in their defence, would require but a very trifling assistance from the Imperial forces to make such a defence possible, as would disincline for any attempt to occupy that country.

I have but a few moments more at my disposal; therefore what I intend to say must needs be very brief. After twenty-five years, we have at last come to the decided conclusion to admit a system of national defence among the institutions of the country. It has always appeared to me that it required nothing but the thorough will of England to make our defence by regulars, militia, and volunteers, perfectly and thoroughly effectual.

And now I would remark upon what I have said, that that country is most fortunate which is so placed that the lines of approach to the objective point, must be known. That is one of the advantages that we possess as an island. We know where troops can be landed. We see how rapidly they can be brought to a landing, and we know what time they take to be disembarked. But here I enter my distinct protest against the idea that our defence is exclusively in our fleets. If we are to retain these fleets for defence in our own waters, we have expended vast sums, and trained generations of seamen century after century, to very little avail, and for very little purpose. The place of the British active fleet is off the enemy's harbours, or searching the enemy's coasts. Defend our harbours by floating batteries, or razées, which can be well employed as a steam guard round the coast. But send the thunder bolts of war where they can be felt by those who would assault you. Do not let them linger in inglorious peace within the four seas of England. To such employment I repeat a decided and distinct protest.

If it will be permitted me, may I for one moment call attention to the ponderation of war, so to speak? for, after all, war is a question of weight, a question of mechanics and mathematics, as in the means of attack possessed by foreign forces. The maps which you see here were made by me in 1855, to show what were the means of resistance by means of our Militia, Pensioners, and Yeomanry alone, without the now existing Volunteer forces, to an invading force of 220,000 men. It will be observed that I have shown the course which an invading army must follow, and what local national forces are available for resistance. Without speaking of the patriotism or national spirit as amongst our best resources, without counting the masses of volunteers, which we could now throw forward with weight of fire, with their splendid rifle practice, I am of opinion that the statutory strength of England is perfectly sufficient, if organised and armed, to cope with any force that can be brought against it, to the extent that I have indicated.

Now, I have said that London is one of the most defensible capitals in Europe; I believe London to be *the* most defensible capital in Europe. The plan before you I made some years since. You will observe there the line of musketry and artillery parapet, and all the various works that support and give flanking fire to those lines. I have supposed that London is defended for the moment merely by 180,000 volunteers, that is to say, a rifleman to every yard of parapet. But in order to advance into the open in line of battle on the Prussian system, and fight under cover of fire from the forts, on the outer line is shown how the troops may be massed for movement. In the inner line is placed an equal number of battalions, the same number of troops. But without the assistance of even slight works, it will be perceived that whereas, in the inner line the battalions can scarcely feel each others' flank, on the outer line, with the assistance of the batteries, they may be formed into substantive brigades and combined into brigades for advance into, and manœuvres in the field. Again, London, from its peculiar position, from the screen of hills that shelters it north and south against hostile observation, from the noble plain of manœuvre that opens to the westward, and from the difficulties and intricacies of the eastern approach, is the most defensible of the capitals of Europe, if we have only made up our mind that it shall be defended. I make no doubt that those who are responsible for defence, are aware of the points at which troops should be massed; and there I leave that question.

But before I conclude, let me with your permission say a few words as to the present state of our home organisation. We have all hailed with great satisfaction the desire of the Government to give effect to the national feeling that a national defence must be organised. We have seen that it was proposed to have depôt centres of recruiting. I have heard officially, that there has been a misunderstanding as to the circumstances under which service battalions will occupy quarters in this country. We are told, and I think it is a most wise arrangement, that depôt companies for the purpose of recruiting, shall be fixed at certain centres, whence they are to draw recruits for the service of their respective regiments. This arrangement, then, shows great wisdom; it is moreover a mechanical advantage. Thus, in the event of a great press or demand, such as occurred during the Crimean War, the weight and pressure would be distributed over many points, and recruits would be drawn from many sources instead of resting an absolute dependence on the same centre of population; for from it, recruits could not be obtained possibly in numbers, certainly not of the quality required, while, at the same time, you fail to interest the whole country in the national effort. Therefore, these depôt centres seem well conceived. But I would suggest whether, of the regiments with which these depôt centres are connected, if one be not constantly on home-service with the depôt, especially in the case of two-battalion-regiments, whether on the whole the advantage that is anticipated will probably be secured? The young soldier, we are told, is to be induced to join from what he hears of the service of the regiment, and from finding comrades in it of his own county. When a regiment returns home from India, if it was directed on its depôt centre, the young soldier, who is then recruited, will learn what are the conditions of a soldier's life in India. But, supposing this regiment has not been completed in its own district, then the previous difficulty is repeated; and you fall into it with the disadvantage of having failed in a plan of much promise. The area of recruiting cannot be increased by establishing depôt centres. What is intended is to make the service more attractive by showing the recruit what he is to expect if he joins his county regiment. I must be forgiven for doubting whether depôt companies dissociated from the head-quarters of the battalion corresponding, are so likely to induce the intending recruit to join as he would do if the regiment were present at these centres on return from foreign service.

Then there is another service. You cannot make the regular service fully acceptable, unless it is acceptable also to the class from which the Militia is recruited. In large towns the recruiting sergeants have prey enough. Those who saw the wretched recruits who were brought up from the manufacturing districts during the Crimean War, will say that such a plan is most dangerous and unsafe, ineffective, and expensive. Perhaps, indeed, in some great stress of war, as the Militia are to assume their place as an army, Militia regiments may be detached to the front; but feeling that you must have recruits of a better class than those we obtain in large masses, and as the object of the "depôt-centres" is to obtain recruits of that kind, and obtain them in that way, the recruit must be satisfied with the circumstance of his service by seeing the home battalion when it returns from foreign service, and to obtain further recruits, it must be made acceptable to the Militia.

Let me state what my experience is of the recruiting service in the Militia. In twenty years I have passed 3,000 recruits through my ranks. I have seen much of them; and especially of late years the recruit is a young man well grown, with a power of growth, without any serious disability or disqualification—I mean other than physical; but the Militia recruit, though he has a man's stature, he has not a man's strength, or a man's skill; therefore, he does not obtain employment all the year round, which employment he comes and supplements in the Militia ranks in an inland county, and in a maritime county in the fisheries and sea service. That lad remains four, five, or six years in the Militia service. At the end of that time he is fully grown—he is a man; he passes off into civil life, and no more is seen of him. But during the period that he might be induced to feel it a fortunate position to enter the regular service, I would take him from the Militia. I would not take a soldier from the Militia in his first year, however long training is given. I would take him in the second year when he came back to the habits which he had formed the first year, and when they were hardening upon him. And taking him in the second year, as a soldier of the line, or a soldier in the artillery, or in whatever branch of the service it might be, I would as an inducement give him one year of line service for his first two trainings which he had passed in the Militia. Unless the depôt-centre system be more acceptable, first of all, to disengaged free recruits, and secondly to the Militia recruits, I feel that the results which we all desire, will not be obtained; and I cannot but think that the best inducement to the young soldier, is the spectacle of the old soldier returning from service, strong in health, strong in character, ready either for future service or for the position of civil life, and returning into his own county, there to carry on whatever pursuits he may think proper.

I thank you for the opportunity that has been given to me to deliver this lecture. I have endeavoured to show that the "strategy of invasion" requires a sterner preparation to meet it than the wars of ordinary times, and that invasion may take place; for I suppose I shall not be considered very distrustful when I say distinctly, that I have no faith whatever in any governmental arrangements in diplomacy. Any moment may bring us to war. I make no imputations; I raise no doubts; but what was true of Holstein is true of Heligoland; what was true of Holstein is true of Belgium. We should be rash, indeed, who are, if not the guardians, at all events the exponents of peaceful enterprise and civil liberty throughout the world, if for want of military preparation, we permitted any to think that they may insult us with impunity, or war upon us with success.

The CHAIRMAN: I am sure that you will permit me to offer your best thanks to Sir Shafto Adair for the very able and instructive lecture which he has just given us. You will readily perceive the amount of ability and study which he has brought to bear upon the subject. It is no new subject to him, for, as he told you, the maps before you are old ones. He has deeply studied for some years past, plans of defence for England, as well as a plan for the defence of London by means of a chain of forts, and he has presented to this Institution a model of that plan of defence.* Sir Shafto Adair commands a very excellent Artillery Militia regiment. From my experience of the Militia, and my knowledge from reading the reports which have been made of his regiment, I may say that he is—not from early education—a most able artillerist. He has not only commanded his regiment with great ability, but he has taken every pains, by going to Woolwich and to Shoeburyness, and by the study of artillery subjects, to make himself a most excellent commanding Officer. Sir Shafto Adair is a loss to the Army. Had he only been brought up in the Army, I am sure we should have hailed him as a most able assistant in developing our military system. I thank you, Sir Shafto Adair, in the name of the meeting, for the lecture which you have just given us.

* The map of London here referred to will be found in vol. vi, p. 538, and the map for Militia formation, in vol. ii, p. 379 of the Journal.

LECTURE.

Friday, March 15th.

General the Hon. Sir EDWARD CUST, G.C.L., K.C.H.,
Colonel, 16th Lancers, in the Chair.

EMPLOYMENT OF CAVALRY IN WAR.

By Captain H. M. Hozier.

"The employment of cavalry in war" may be divided under two heads—the strategical employment and the tactical employment. Of both of these, various examples were furnished during the late war in France; but the strategical employment of the German cavalry was conspicuous from the very moment of the outbreak of hostilities. As soon as war was declared, the Prussian cavalry belonging to the *corps d'armée* of the western provinces was hurried to the frontier, and there established a line of posts. But it was not content with merely watching the enemy, or endeavouring to screen from observation the movements and dispositions of the heavy columns that were being pushed up in its rear. Almost instantaneously after the declaration of war, this cavalry began to prove on the frontier the ability and intelligence which had been so carefully cultivated during peace. With an audacity which astonished its opponents, it quitted without support its own territory. Officers and troopers alone or in small bodies dashed into France. Sometimes in groups of six or seven, they made wide raids into the hostile territory, broke the lines of telegraph, rushed through the villages, picked up stragglers and prisoners, carried off a few magistrates who might give information as to the expected movements of troops, and returned in safety to their own territory.

The French cavalry was more slow to take the field than the Prussian. This was in great measure due to the difference of organisation. In Prussia each regiment of cavalry consists of five squadrons. Of these, four are field squadrons. As soon as the order for mobilisation arrives, these four squadrons are filled up from the fifth squadron and local reserve, to war strength, and are immediately ready to take the field. An Act of Parliament is always in force by which horses can be taken from the various districts of the country at an assessed price, fixed by a mixed civil and military tribunal.

In France, on the contrary, there was no localisation of corps; the men of the reserve had often to traverse enormous distances to reach their regiments, and then sometimes found them already marched away. There were no normal depôt squadrons, and no properly organised system of obtaining immediately the extra horses required in war. Thus the French were still engaged in preparation, while the Prussian horsemen were not only already in the field, but making raids to considerable distances into French territory, which caused serious inconvenience to the French military authorities in their arrangements for the early dislocation of the troops. The French cavalry, the branch of the army which should have been the first arm mobilised, which should have been ready to cover every movement of its own infantry, and spy out every movement of the enemy, was, through the vice of a faulty administration, the arm last ready to take the field, and instead of opening the march of the Army, was only in time to close it. This was the fault of proper organisation; no blame can be laid upon the gallant leaders of the French cavalry, who afterwards so nobly endeavoured to atone with their blood for the errors of administrators.

But when the French cavalry did reach the frontier, it was found that it had been servilely trained in those exercises alone which had been laid down in 1829, and which still remained, with unimportant alterations, the standard text book of the service. A French Officer, Colonel Bonie, who has written a most interesting work on the subject, describes the French cavalry as having learnt nothing in the way of science, and forgotten nothing in the way of bravery, but regrets that consequently its bravery could only save its honour without gaining victory as a recompense. The same Officer also fully recognises the great superiority of the German cavalry in everything connected with activity, outpost duty, or reconnaissance, which he attributes in great measure to the power possessed by the Prussian Officers of reading maps easily. This power permits them readily to find their way in a strange country. He says, "the reading of maps among the Prussian "Officers is as easy as that of an open book. Among us, on the con- "trary, it is a fog; it was in consequence, with a radical vice, that we "entered upon the campaign; the result was a disadvantage, for which "the most brilliant courage could not compensate."

It is the author of the above who also says, that, in consequence of having practised without alteration the old-fashioned field exercises, when the French cavalry was in the line of outposts brought face to face with the Prussians, it had no idea of the active and dashing method of reconnoitring which the Prussians employed. Instead of employing single horsemen or small groups, the French employed troops, squadrons, and even regiments to reconnoitre; and with these attempted heavily to check a light enemy, whose movements were most rapid on account of their good horses and small numbers, and who eluded by activity the force which sought to grasp him. Thus the French cavalry was wearied out even before the first battles. To this it is due that, in the early portion of the campaigns, in every action the

French were surprised. The French cavalry was at every point either outwitted, or worn out by incessant marching and counter-marching. Without its cavalry, the French Army and its Generals were not only deprived of their own military eyes, but were laid open themselves without screen or hindrance to the unremitting and incessant vigilance of the military eyes of their enemy.

Part of the weariness of the French cavalry at the very outset of general hostilities, may be doubtless traced to the different manner in which the cavalry was distributed in the two Armies. In the French Army, the various regiments of cavalry were formed into large divisions or even corps, each of which was attached to an infantry corps, and placed under the command of the leader of that corps. In this way the Generals commanding cavalry divisions had great responsibility, but little independence, a certain method of insuring tardy and slow operations. Those who advocate such a disposition of cavalry assert, that unless the cavalry is under the same General that commands the infantry of a corps, the cavalry may move away and leave the front of the unconscious infantry uncovered and unwatched. In the Prussian service a principle has long been adopted which meets this difficulty. To each division of infantry (12,000 men) is permanently attached a cavalry regiment of 600 horses, which furnishes all outposts and vedettes required by the infantry. The remaining cavalry regiments of each corps are amalgamated together into independent cavalry divisions, which can be directed as required to an exposed flank or a dangerous point, which can be pushed miles and miles in front of the Army, and the leaders of which possess that independence and power of prompt action which is so necessary for the efficiency of the arm that they command. Since in our service the artillery has lately been emancipated by the orders of His Royal Highness the Commander-in-Chief from servile adherence to the movements of infantry, it is not unreasonable to hope that an arm still more mobile, and whose action must almost be as swift as the thought that dictates it, may, after the security of the infantry has been provided for, be entrusted to leaders placed in direct responsibility to the Commanding-General of the Army.

It was with regard, however, to these cavalry divisions that one of the few Prussian errors which could be detected in either the organisation for or conduct of the campaign may be perceived. Unlike all other portions of the Army, the Prussian cavalry division is not organised in time of peace, and had to be composed at the commencement of the war. As actually occurred, the delay that was required to carry out this formation was of no practical importance, but had the French Army possessed a first-rate plan of mobilisation, the disadvantage of not having already in peace told off the different regiments to form each division would doubtless have been experienced.

So much for the preliminaries of the campaign. These continued for twenty days, during which the Prussian Generals were, by means of their cavalry, correctly informed of every important movement of the enemy; while the French Staff were ignorant of even where the headquarters of the various German Armies lay. At the end of that time, so perfect in Germany was the machinery of mobilisation and the railway transport of troops, that more than 500,000 men were close down to the French frontier, and ready to advance into France. These 500,000 men were divided into three armies, under the respective commands of the Crown Prince (left), Prince Frederick Charles (centre), and Steinmetz (right). The German plan was that the three armies should advance simultaneously in a south-easterly direction. Three German armies, roughly, were on the frontier. The Crown Prince lay about Speyer, Prince Frederick Charles in the centre, and General Steinmetz on the right flank. The idea was that the Crown Prince should move down between the Rhine and the Vosges Mountains, and Prince Frederick Charles and General Steinmetz on the western side of the Vosges Mountains, so that if the French concentrated against the Crown Prince, the whole of the Vosges Mountains would be turned by Prince Frederick Charles and General Steinmetz; while, if they concentrated against Prince Frederick Charles, the Crown Prince was to push through the Vosges Mountains and take them in flank and rear on the other side. As the Crown Prince had to move *through* the mountains, he had only one cavalry division in addition to regiments attached to infantry divisions. The rest of the cavalry were attached to the more northern armies.

While the German Armies, shrouded by their cavalry, were silently massing on the frontier, the French Army, totally ignorant of the designs of its enemy, lay in scattered detachments from Sierck to Belfort.

On the 4th of August the French corps which occupied St. Avold, a small town on the road from Metz to the frontier line of the Saar at Saarbrück, made a movement towards the latter place. The Emperor and the Prince Imperial were present, and the French soldiery thought that the advance had at last really begun, and that they were upon the high road to Berlin. The movement was not however pushed for one reason, viz., that it would have been extremely hazardous to have made an advance without some knowledge of the enemy's positions; and such knowledge the activity of the German cavalry prevented the French from collecting. It was the more extraordinary that the French had evidently so little studied or practised this primary duty of light cavalry, as after the campaign in Italy of 1859, the Emperor Napoleon himself had drawn the attention of his Officers to their inferiority in this respect to the Austrians, and had ordered them to devote themselves to the study of "outpost duty." It is clear that the Emperor's orders had not been cordially obeyed, as the Crown Prince was able totally unperceived to mass his forces behind the dark fir woods that lie north of Weissenburg. Here were posted the troops of General Douay, the advanced guard of the corps of Marshal MacMahon. These passed the night almost within earshot of the whole Army of the Crown Prince, but their cavalry gave them no warning of his approach. While they were wholly unsuspecting, the Crown Prince sprang upon them on the morning of the 7th, and drove them back with great loss on the main body of Marshal MacMahon at Wörth.

In this action of Weissenburg, which was fought among rugged and hilly ground, little opportunity was given for the action of cavalry on either side. The French cavalry only came into action when the contest was already decided, and its infantry already in retreat. The German cavalry found no ground suitable for its movement, but this made it only the more active and unwearied in pursuit of the beaten foe. A French Officer, writing of the retreat from Weissenburg, says, "The weather was fearful; a storm broke out, and torrents of rain "transformed the fields in which we camped into morasses. Not-"withstanding this hurricane, the enemy's vedettes never lost sight of "us; ever on the watch, they studied our positions, reported that we "were not sufficiently strong to fight, and allowed their Army to pre-"pare everything for an attack at daybreak."

In consequence of the excellence of these vedettes, Marshal MacMahon, on the 6th of August, was obliged to accept battle at Wörth, without any idea of the line of march or strength of his opponent. His considerable cavalry of reserve (six regiments of cuirassiers, and two of light cavalry) being hermetically attached to the infantry, was not, as reserve cavalry should be, kept out of fire, but massed in rear of the centre and right wing. Here, soon after the commencement of the action, it was reached by the German shells, and suffered perceptible loss. At last four regiments of cuirassiers were launched against the enemy to restore the battle, which was being quickly lost. Without any preparation, without in any way reconnoitering the ground over which they had to advance, they dashed forwards with the old French enthusiasm. Only a débris of the glittering squadrons returned, without being able to reach the ranks of the enemy, who was unassailable on account of his fire and his position. The Germans, unimpeded by this unfortunate charge, continued to press forward. The French infantry, taken in front and flank, and deeply ploughed by artillery, began to waver heavily. There was only one hope left of saving the infantry; it was the cavalry. Again two Cuirassier regiments thunder against the enemy; again only a few bleeding fragments rush back. The enemy still press forward; and hundreds of fallen men and horses proclaim the impossibility of the success of a cavalry charge against infantry not thoroughly shaken by the fire of artillery or small arms. But these charges were not even made with the best chances of securing success. It was not fully explained to the leaders of the cavalry what was the object of their attack. They were merely told in vague terms that they were to impede the advance of the enemy. The ground over which they were to pass was on this occasion, as on many others during the war, wholly unreconnoitered. As Colonel Bonie, himself an eye witness on the French side, writes, "They, the Cavalry, set out without knowing their object; they "galloped far and wide, and, after having lost many men, those who "escaped, returned without having been able to close with the enemy "or to make use of their arms." Far different was the case in the Prussian service. There no regiment ever moved in line or any close formation without being preceded by scouts. These are usually selected as the best riders in the regiment. They move forward at a rapid pace in front of the regiment, and if they come upon an impassable obstacle, such as a morass or a rivulet, gallop along its bank till they find a passable point, and then halting for a few moments, form a landmark to guide the march of the regiment.

Valuable experience with regard to the cuirass was, however, gained in the battle of Wörth. Like the noise of hail on window panes was heard the sound of the bullets on this defensive armour, but no cuirass was pierced, and cuirassiers were seen dismounted, but unwounded, in large numbers. This remark is important, because it demonstrates the necessity of preserving these cuirassier regiments, which some have pretended to be mere relics of mediæval absurdity. It has indeed been urged, that in consequence of modern inventions, the cuirass is solely fit to adorn the museum of the antiquary. The contrary has now been practically proved to be a fact, on the field of battle; and heed should be taken of this fact in the composition of future divisions of cavalry.

There seem to have been, in the French Army, as many controversies and as much dispute on the score of the responsibility for these rash cavalry charges at Wörth as there were on the subject of a light cavalry charge in which our own countrymen rode on a memorable occasion to a glorious decimation, or perhaps rather annihilation. A French eye-witness gives as his experience of the result, that an Aide-de-camp sent with an order to a cavalry Officer to charge, should not appear flurried; for the instinctive idea of the leader is to start on the instant, without, so to speak, taking time to reflect. The sentiment is perfectly natural, since such a leader fears above all else, to be accused by his troops of hesitation or wavering. But if he does not clearly comprehend the aim of his attack, and take time to reconnoitre the ground over which he must advance, he is very likely to cause the total loss of his troops.

Such was the case at Wörth. The wholesale sacrifice of the cavalry saved nothing before the rout of the infantry, and having been sacrificed, was of little use to retard the pursuit after the rout.

Marshal MacMahon, after his defeat at Wörth, retreated on Chalons, closely followed by the Prussian cavalry. All accounts of the action of the latter, from the French as well as the German side, are continuous praise. The French troops were continually harassed by the enemy's presence. To move more rapidly, they sacrificed baggage, equipage, and provisions. Living on what they could hurriedly gather from the country people, they pushed forward, without pause and without any lengthened halt. On the 10th August they reached Luneville, and here hoped to have outstripped their pursuers, and to have a momentary rest. Fires were lighted, rations were served out, and the men began to cook their dinners, when suddenly an order to march at once, arrived. The camp kettles were overturned, the forage was taken away from the horses, and they bridled up in all haste. It was again the enemy's cavalry which was closely dogging their footsteps, and denied them even half an hour's repose. Ever nearer and nearer still, the Prussian cavalry closed on the hurrying columns. Prussian Uhlans dashed into Luneville, almost before the French vanguard had left. Some squadrons even pushed beyond the retreating enemy, occupied the road he wished to take, and forced the whole army of Marshal MacMahon on to a different line of retreat. In such cases not only the physical, but the moral force of cavalry, came vividly into play.

By the action of Wörth and the subsequent retreat, the French cavalry of the corps of Marshal MacMahon and de Failly was ruined. This ruin was possibly accelerated by the system of bivouacking instead of taking up quarters. The Prussians, on the contrary, always take up quarters, where possible, in villages, instead of bivouacking in the open. This system allows the troops and horses to rest better, and is less severe on the inhabitants of the country, as it does not ruin in the same manner their fields, gardens, and orchards. Many authorities who have written on this subject, have expressed their opinion that nothing reduces the strength of the horses so much, as a continued series of night bivouacks; nothing undermines discipline more, than allowing the men to get accustomed to take everything just as they find it, or the necessity of permitting them to disregard the cleanliness of their persons and equipment; which it is impossible to insist upon, when they are exposed day and night to all weathers. Outposts unfortunately must bivouac; but this necessity should apparently be as far as possible reduced to a minimum. The use of camp-equipment seems to be inadmissible for cavalry in war. In case of hurry or surprise, it would be impossible to pack it in time to allow the squadrons to be of use, and in Europe, where there are always plenty of villages and farms, its employment would be only an incumbrance.

Having so far followed the cavalry, which acted at the commencement of the campaign under the Crown Prince, we must turn to that under the orders of Prince Frederick Charles. This General had under his command five divisions of cavalry. With these he formed a screen across the front of his Army when he pushed forward, sometimes as far as 60 miles in front of his head-quarters; and it is said that the Emperor Napoleon stated, that this screen completely shrouded all dispositions of Prince Frederick Charles, while it is well known that the Prince, by means of his cavalry, was fully conversant of all the general movements of his enemy. Guided by this information, the Prince, directing General Steinmetz to move on Metz, moved himself on Pont-à-Mousson.

General Steinmetz was ordered to march to Metz. As soon as the defeat of Marshal MacMahon at Wörth had been assured, the whole of the French Army began to fall back, and the left wing to concentrate towards Metz. General Steinmetz was ordered at once to push forward along the main road towards Metz. Prince Frederick Charles moved forward to Pont-à-Mousson, and the Crown Prince gradually pushed forward to Nancy.

On the 14th August, General Steinmetz attacked the French rear-guard in front of Metz, and held, in consequence, the whole of Marshal Bazaine's Army in check, and prevented its retreat beyond Metz. On the same night, the cavalry of Prince Frederick Charles crossing the Moselle above Metz, threw its vedettes on to the road by which Marshal Bazaine must retreat from that fortress, in order to concentrate with Marshal MacMahon at Chalons.

On the morning of the 15th, the French General Forton was sent to clear this road, but found that the hostile cavalry had stretched a cordon there, and threatened to envelop the army of Marshal Bazaine in its meshes. To drive away these horsemen the French opened an artillery fire, which naturally did little execution among the isolated vedettes, while the supports were hidden in the indentations of the ground. During this artillery action the Prussian horsemen observed what they required. It is of course easy now to perceive that if General Forton had pushed forward boldly, he might have swept their unsupported cavalry away, but he could not, from the want of knowledge of outpost duty among his cavalry, tell what was before him, and the consequence was that the Prussian cavalry held its ground in the vicinity of Mars-le-Tour.

While the cavalry moved and held the French in check, Prince Frederick Charles was able to bring up two *corps d'armée*, and on the night of the 15th and the early morning of the 16th he threw them right across the road by which Marshal Bazaine wished to retreat on Chalons to join Marshal MacMahon. It was the result of these movements that brought on the battle of Vionville, which was the most important battle of the war, as far as the "tactical action" of cavalry was concerned.

Marshal Bazaine had determined to march early in the morning of the 16th August. The cavalry of General Forton was to move at 5 a.m. to lead the march, but something apparently delayed the French movement, and a countermand arrived at 9; and although the enemy's vedettes were known to be close at hand, it seems to have been totally unsuspected by the French staff that a strong force could be ready to bar a way. The cavalry unbridled, and, what can be hardly comprehended, with the enemy's vedettes so close, even took off their saddles. Some troopers were sent out as outposts, and the Officer in charge of them twice reported that considerable numbers of Prussian artillery and cavalry were approaching. A staff Officer was sent to examine these, but reporting that nothing serious impended, orders were given for three squadrons of each regiment to retire out of sight, while the fourth remained on guard.

While these squadrons were at ease, four Prussian horse artillery batteries, with two cavalry regiments, galloped up and opened fire. The French cavalry were suddenly disturbed by the German shells. They were quite taken by surprise. Forton's dragoons lost their heads, threw themselves on to their horses and fled, and the Officers could with the greatest difficulty get together a few troops. The result of this panic was, that the two cavalry regiments which accompanied the Prussian horse artillery batteries were able to force back two cavalry divisions, consisting of two regiments of cuirassiers, four regiments of dragoons, and two regiments of chasseurs, as far as Villers aux Bois. The French cavalry cannot be accused of want of courage; courage of the highest order they universally exhibited during the campaign, but on this occasion, by remaining quietly on the defensive, they allowed themselves to be surprised and thus lost their heads. Had they, instead of remaining calmly on the defensive, sent forward even a few troops to make a dashing movement in advance, they would have discovered that their enemy was in much weaker force than themselves, and could have been driven off. This is an example of the old rule which has so often been laid down, that cavalry should never unsaddle or go to rest, till it has thoroughly cleared its front and reconnoitred all ground from which a blow can be struck against it.

Soon afterwards, the Prussian infantry of the 3rd corps came into line against the French left; and Bataille's division of the second French corps began to be severely pressed by the 6th Prussian infantry division; two squadrons of French Lancers were sent forward, apparently to attempt to silence the Prussian batteries which supported the 6th division, but were forced to return under the fire of the Prussian skirmishers. General Desbaux's cavalry division of the Guard was near at hand, so General du Preuil received orders to charge with the two Cuirassier regiments of his brigade. He remarked that the distance to be traversed before reaching the enemy's infantry was too great to allow the charge to be successful, and begged that artillery might at least to some degree prepare his attack. "Charge at once," said General Froissard, "or we are all lost," and the Cuirassiers rattled forward in three echelons, as if on parade. As the cavalry General had foreseen, the attack failed. The brave horsemen came upon unperceived obstacles of terrain, horses were in great numbers shot down, and while impeded under a heavy fire, were charged by Prussian hussars, who drove them back fighting, almost to the very position of Marshal Bazaine in person. Two fresh French squadrons here fell on the hussars, and saved Marshal Bazaine from capture.

To disengage the Prussian hussars, who were severely pressed, it was necessary to send forward the 6th Prussian cavalry division, which did disengage the hussars, but pushing on came into such a terrible fire at 500 paces distance from the intact French infantry, that it had rapidly to retire. This engagement occurred south of the main road.

Between 2 and 3 p.m., north of main road, the Prussian brigade Breslow, consisting of three squadrons of 7th Cuirassiers and three squadrons of 16th Uhlans, received orders to attack the French artillery near Rezonville, in order to give relief to the Prussian infantry, which was suffering severely from these batteries. It was a most dangerous duty which these squadrons had to perform. They rode forward exposed to heavy artillery and infantry fire, but carried the guns, cut down many gunners, and passed beyond the batteries. Here they were fallen upon by the two French cavalry divisions of Forton and Vallabrégne, and a desperate *melée* took place in which the Prussians suffered very severely. But their charge had the desired effect, for after the *melée*, the French cavalry had to retire to restore its order, and an attack which was being prepared against the left flank of the 6th Prussian infantry division, and which threatened to be very dangerous, had to be abandoned. In this case the Prussian cavalry, though it suffered very severely, was not uselessly sacrificed.

With reference to this *melée*, Colonel Bonie says that the French suffered much less than the Prussians. They used the point, while the Prussians cut, and it was found in the *melée* that while those who cut, only wounded the horses, and could not injure the men protected by cuirasses, those who pointed killed the men through the interstices of the cuirass. This is not a new experience. So long ago as the time of the Peninsular war, Marshal Marmont recommended to the Emperor Napoleon 1st that cavalry should be armed with three-edged swords, so as to make cutting impossible.

Another serious cavalry contest occurred during the battle, brought on apparently by an attack of some French squadrons on a Prussian battery near Mars la Tour. Both sides were gradually reinforced, till six Prussian regiments and eleven French were engaged hand to hand.

These were not all the cavalry engagements of the day. On the Prussian side there were 22 regiments in the field, of which 19 took part in the various charges; the French brought 28 under fire, of which 22 were actively engaged. Thus about 25,000 horses were engaged. Eight times were there charges by the cavalry on both sides on artillery or infantry, in which the hostile cavalry came to the rescue, and twice there were serious hand-to-hand contests of large numbers of horsemen. For ten hours the battle continued, and some of the German regiments were seventeen hours in the saddle.

A French writer, speaking of this battle, says that it was by means of the action of his cavalry that the enemy was able at the commencement to supplement his numerical inferiority by replacing the troops which were wanting by reiterated charges, which brought a period of forced quiet, and so allowed time for his reinforcements to arrive.

When we consider that Prince Frederick Charles, by means of the action of his cavalry, was enabled to hold in check for the greater part of a long summer's day the whole of Bazaine's Army, 180,000 strong, with only 24,000 infantry, it must surely be acknowledged that the effectual action of cavalry, even on the very field of battle, is not, despite modern inventions, a matter of the past, as some are prone to argue.

Critics on this battle have said that the cavalry on both sides attacked at too great distances, and so took too much out of their horses before the final close; but it must be remembered that the ground was particularly open, and gave little opportunity for unperceived approach. It has also been said that both sides attacked infantry and artillery which had not been previously well shaken by the fire of the latter arm; but the Prussian cavalry had by self sacrifice to compensate for the absence of the other arms, and the French had at all price to break through, before the arrival of these arms, so that there was little time on either side for a scientific display of artillery fire. The rule is doubtless good, but the exception may be allowed under exceptional circumstances.

Colonel Bonie draws considerable attention to the superiority which the Prussian cavalry gained in hand-to-hand contest over the French, from the excellence of their horses. The Prussian horses are excellent and very well bred.

There was a large number of establishments throughout the country for breeding cavalry horses. The sires were also available for farmers in the district, on the condition that their foals should be available for military purposes, if required, at a certain price. The French light cavalry were generally mounted on Arabs. As a rule, these Arab horses were found in the *melées* to be too small and too light to resist the great onset of the Prussian attack. There is no doubt, as German and French critics on this battle remarked, that the Prussian cavalry always had a great moral effect from the size of the men and horses. Still it appears to have been supposed that the Prussians always employed heavy cavalry in this encounter. That was not the case. The Prussian Dragoons were light cavalry, only the Prussian light cavalry were almost as heavy as the French heavy cavalry, except the Cuirassiers and the Carabineers.

Colonel Bonie thinks that heavy are better than light cavalry. Doubtless in the shock it has greater weight and greater moral effect.

The battle of Vionville was succeeded in two days by that of Gravelotte.

Gravelotte was almost entirely an infantry battle, except in the single instance, when a French cavalry regiment came into play. A regiment of Chasseurs in a charge was stopped by a wall, was held there under infantry fire, and lost an enormous number of men and horses.

The result of the battle of Gravelotte was, that Prince Frederick Charles, being supported by the King, threw back Marshal Bazaine into Metz, and surrounded him there. As soon as this was accomplished, Prince Frederick Charles was left with his Army to surround Metz, and watch it till it fell, which it did in October. During the investment of Metz, cavalry were of little use. Three of his cavalry divisions were therefore taken from him, and sent to the Army of the Crown Prince. The Crown Prince, during the time that these actions of the 16th and 18th at Vionville and Gravelotte were going on, halted at Nancy, and during this halt Marshal MacMahon gained several marches from him, and the Prussian cavalry lost sight of the French. As soon as the Army of Marshal Bazaine was securely invested in Metz, the Crown Prince set out from Nancy, in order to follow the Army of Marshal MacMahon to Chalons.

On the 16th of August the Crown Prince had reached Nancy, and halted there till after the battle of Gravelotte. He then advanced. After the battle of Wörth, the Armies of Marshal MacMahon retreated on Chalons. They were there reorganised and recruited by the levies of recruits that could be hurried up from Paris and from the various provinces of France. Thirty-three cavalry regiments were given to this new Army, of which fifteen were light. The Marshal was determined to relieve Metz. The idea was that he should move from Chalons on Rheims, by Rethel, Mezières, and Sedan, down to Thionville, leaving the Army of the Crown Prince well to the south. On this march the French cavalry seem to have been of as little use as vedettes as they had been before Weissenburgh.

One Cuirassier regiment and three regiments of Chasseurs, were on the right flank, two of Hussars were sent to the passage of the Argonnes; the other regiments marched compact with their corps.

The halt at Nancy had delayed the Crown Prince's cavalry, and they had lost MacMahon; when the Crown Prince was at Ligny his cavalry discovered his line of march, and never lost it again.

Marshal MacMahon moved by Rheims, Mezières, Sedan, with Thionville as his object. He could learn nothing of the enemy's movements, but at every step his army encountered hostile vedettes, and even little groups of five or six horsemen, who appeared and disappeared incessantly, but always without the possibility of attacking them. The French cavalry always marched without reconnoitring. Once a strong force approached a wood in which were Prussian dragoons dismounted, and was only saved because the latter fired a little too soon.

It is said that on this march the Emperor's own household was sent forward to take up quarters for him. A few days before the battle of Sedan they arrived at the top of a hill, and were moving down quietly with an escort of the Cent Gardes towards a village where they intended to pass the night. As they approached the village an old woman came out and met them. They asked her what troops were in the village, expecting to find some other French cavalry were there, on which she told them the Prussians were there. That was the first intimation they had that the Prussians were within half a mile of them. Almost at the same moment that they obtained this information, the Prussian shells opened upon them, and they with difficulty retreated without capture.

When the Crown Prince found the direction that Marshal MacMahon had taken, he altered his march, which had been directed on St. Menebould, to Sedan. He turned his army, which had been directed to move along the Marne towards Paris, and struck across the country towards Sedan. At the same time the army of the Crown Prince of Saxony, consisting of three *corps d'armée* and one cavalry division, was detached from the army of Prince Frederick Charles, and hurried across the country in order to head Marshal MacMahon as he came down towards Thionville, while the army of the Crown Prince should attack him in flank. On the 30th of August the Crown Prince of Saxony again surprised the French at the village of Mouzon. On the same day the Crown Prince surprised them at Beaumont. In neither case were the outposts properly secured. Of course the Prussian advantage, and the means by which they could conceal all the movements of their infantry, in order to strike their sudden blows, were entirely due to the information which was brought in by the cavalry vedettes. The fifth French corps was almost entirely overthrown, and when it was being rapidly annihilated, again the French General sent forward a Cuirassier regiment to attempt to save it. They engaged in a vain attempt, their horses were shot, they themselves were dismounted, and the whole regiment was nearly destroyed, and, of course, could have very little effect in averting the impending ruin of the infantry. On the 30th of August, that same night, the retreat commenced upon Sedan in great disorder.

During the retreat the following day, the reiterated attacks of the Prussian cavalry spread a panic and disorder among the French. The French cavalry, instead of covering the retreat, moved compactly with the infantry corps to which it was attached; instead of disputing the ground and reconnoitring the enemy, they were generally in front of the infantry, offering an obstacle to its advance.

So bad was the information which the French cavalry brought in that Marshal MacMahon, in falling back on Sedan to fight, thought he had only 60,000 men behind him, while in reality he had 200,000. If his cavalry had been able to do their duty better, instead of falling back towards Sedan, he might perhaps have crossed the frontier, and so avoided the catastrophe that occurred at Sedan.

During the actual battle at that place, two great cavalry charges were made by the French with great bravery, but too late, and without proper precautions. The cavalry went forward, but only again to add to the hecatomb of wounded and slain.

The consequence of the catastrophe of Sedan was that the Crown Prince was able to invest Paris, and during the next few weeks, the war was a war of sieges. Prince Frederick Charles was investing Marshal Bazaine in Metz, and the Crown Prince, General Trochu in Paris. The cavalry could not be employed largely. The Prussian cavalry covered the siege, and scoured the country everywhere.

After the fall of Metz, Prince Frederick Charles marched rapidly in order to cover the army besieging Paris from a contemplated attack from Orleans. But before the Prince arrived, this army had been held in check by two divisions of cavalry alone. They never came to any serious encounters, but, by cutting off vedettes, and always surprising the French whenever they approached any village, they kept them in a constant state of fidget, until time was given for Prince Frederick Charles to come up and put about 80,000 men between Orleans and Paris. The French cavalry, which had been the cavalry of the army at the commencement of the war, was entirely ruined by the capture of Metz and by the capture of Sedan. A few regiments escaped from Sedan, but they reached Paris in such a demoralised state that they were hardly able to take the field. The Prussian cavalry continued the war in the same way, always active and always vigilant. The French cavalry was not able to compete with it. Gradually, the Prussians finding there were no horsemen to oppose them, became bolder and bolder. At the battle of Orleans several instances occurred in which the cavalry rode right into the infantry, and in one instance a cavalry regiment of Prussian hussars suddenly dashed forward and captured a whole French battery, with the gunners and horses, and drove it into their lines. During the remainder of the war the Prussian cavalry was active, ubiquitous, intelligent; it saw everything and announced everything. The French cavalry was ruined, and there was no means at the moment of supplying its place. Hasty levies were of little good.

I have endeavoured to put forward as succinctly as I can the general features of the cavalry actions during the campaign. I only wish now to lay before you a few deductions which I have collected from various books and writings which have appeared lately, both on the subject of this war and others.

It appears that since the invention of rifled arms, cavalry must act at greater ranges in front, and on the flanks of an army during the operations before and between the battles, and that a larger force of cavalry than formerly must be maintained. There should be two distinct modes of employment of cavalry, first, as cavalry attached to infantry, and, second, cavalry in divisions. In the Prussian service there are about one horseman to every twenty infantry, to do the duty of outposts; one horseman to every twenty men in the army to do the duty of the divisional cavalry. Cavalry should be organised so as to be mobilised with extreme rapidity in case of war. It should have normal depôt squadrons formed in peace, and means should be taken to insure the power of obtaining horses with great rapidity. Cavalry should be told off in peace to accompany infantry. Officers should be well instructed in reading maps, knowledge of country, and outpost duty during peace. During the Prussian manœuvres, though the troops rested at night, the Officers who were in charge of the outposts were expected to be alert and vigilant all night, so that the commander of the division coming on the ground next morning expected the outpost not only to tell him where the enemy was, but what forces of different arms were lying in the different villages along the line of his outposts. Next, as cavalry must move far in advance of infantry, there must be means of sustaining it independently of the ordinary commissariat. The Prussian cavalry during the war used the system of requisitions. Their advanced troops went into the farms and villages and took whatever hay and corn they wanted. Of course, in a less fertile country than France such a system would be impossible, and the only way it could be compensated for would be by having some system of light waggons attached to the cavalry, or by the troopers carrying their supplies themselves. Cavalry must move over great distances rapidly. All weight that can possibly be taken off the horses should be diminished. From various accounts of the late war, most of the critics on cavalry-matters seem to hold it as extremely advisable that the man should be as heavy as possible, because he uses his weapon with so much more advantage in a close hand-to-hand contest; and some have proposed that the only way to lighten the weight on the horse, and still to retain a heavy man, is to abolish the pack altogether, and the heavy saddle which is required to carry the pack. They argue that in these days of railways, an army never moves far from its line of communication, and that it never can move above three or four days, constantly keeping in motion; that there is plenty of time during the various halts to bring up the baggage; and even if there is not, that the men, if properly equipped, ought to be able to go six weeks without any change of clothes, or without any re-adjustment of equipment. Several writers are especially loud in declaiming against dismounted men being attached to cavalry regiments. They hold that dismounted men, when cavalry are really acting far to the front, could never be up in time to be of any use. As concealment is very necessary, several writers have urged that head collar chains, and steel scabbards, and everything that glitters in the ranks of cavalry, should be abolished; that all burnishing should be abolished, and that spurs and stirrup irons should be browned like gun-barrels. Others assert that as men must now ride for very long distances, sometimes forty or fifty miles, generally at a trot, they should be permitted, except when on parade, to rise in their stirrups. Then, they assert that cavalry should never encamp, if possible, but always take up quarters, and if surprised in their bivouacs or quarters, defend their horses on foot with their firearms. They think that reconnoitring cavalry should act individually, or in small groups, and that, for tactical purposes, the cuirass should be much more largely introduced into the service.

The CHAIRMAN: I think everybody will agree with me that a clearer account of a campaign has never been given than that which has now been given by Captain Hozier. It is the more gratifying to me as an old cavalry Officer; and we need be under no despair about our arm, about which some persons say that it is now of no use at all. In the campaign just described, cavalry have taken their part, just as distinctly as they have done in previous campaigns. I do not think it is possible for any misgiving to be entertained about the use of the arm after the account that we have heard. It is very clear that when cavalry are under proper discipline, properly looked after, and properly commanded, there is no reason to doubt for a moment, that we shall maintain our ground in any future campaign as effectually and as usefully as we have done in past campaigns.

Evening Meeting.

Monday, April 8th, 1872.

Rear-Admiral A. P. RYDER, in the Chair.

NAMES OF MEMBERS who joined the Institution between the 19th March and the 8th April, 1872.

LIFE.

Northbrook, Right Hon. Lord, Viceroy and Governor General of India.
Dennistoun, R. J. W., Lieut. 64th Regt.
Graham, Cyril, Esq., late Governor Red River Settlement.

ANNUAL.

Reamsbottom, Alfred, Lieut. 82nd Regt.
Loder, F. C. J., Lieut. 82nd Regt.
Boycott, William, Major 29th Regt.
Deering, Charles L. H., Lieut. 28th Regt.
Smith, S. Milne, Major late 3rd W. York Rifle Volunteers.
Law, E. F. G., Lieut. R.A.
Gawler, John Cox, Colonel 73rd Regt.
Chichester, Sir Alexander P. B., Bart., Lieut Devon Yeo.
Stephenson, Charles, Captain 22nd Middx. Rifle Vols.
Trench, Hon. C. G., Captain 1st Royal Dragoons.
Gordon, Alexander W., Lt.-Col. 61st Regt.
Hickson, Robert A., Lieut. 3rd Buffs.
Murchison, K. R. Esq., formerly of the 13th L. I. and 58th Regt.
Hammick, St. V. A., Capt. 43rd L. I.
Quick, George, Esq., Engineer R.N.
Cooper, William, Lt.-Col. 70th Regt.
Davidson, John, Esq., Master Royal School of Naval Architects.
Stock, H. J., Capt. Bombay Staff Corps.

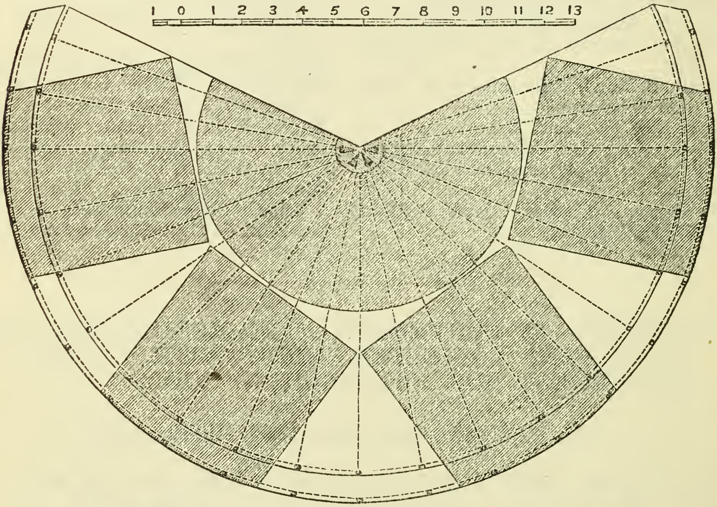
A METHOD OF CONVERTING THE REGULATION BELL TENT INTO A SHELTER TENT: WITH A NEW ARRANGEMENT FOR ENTRENCHING TOOLS.

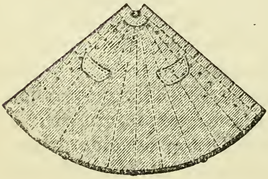
By W. James, Esq., late 42nd Highlanders.

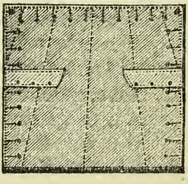
The proposal which I am about to bring before you, and which has to do with the question of shelter-tents and entrenching tools, is made from motives of economy. My shelter-tent is composed of six pieces of canvas, and I propose to show how it can be cut out of the bell-tent. It is hardly necessary for me to say much upon the question of the shelter-tent. It is a subject which does not seem to have occupied the attention of Government with regard to the British Army of late years; there has been a prejudice against it; but on examining the bell-tent, I think that you will find my proposal worthy of consideration.

The bell-tent is a very ancient institution of the British Army, and no doubt it has been modified a little from time to time. It is my opinion that the time is come when it may be further modified, and I think that my plan will contribute to that result. The bell-tent costs about £3 10*s.*; and if it cost that sum and nothing more, we might be content with it. But that is not all; the carriage of it increases its cost seven or eight times. These are economical times; but I trust that they are efficient times also. If you can combine efficiency with economy, then, I think, the question is settled. Now, I undertake to combine efficiency with economy.

I think I have shown that the bell-tent is not economical. Now let us see whether it is efficient. I admit that it is a very good tent, if you can have it when you want it; but it cannot always be at hand when it is required. In the case of a regiment marching along a good road, or where you can get your pack-animals to keep up with the regiment, you can get your bell-tents up; but even then there is a considerable amount of delay in the matter. But supposing you are going over ground impassable to animals or carriages, what are you to do then? You have to bivouac. Now bivouacking in fine weather is not at all an unhealthy thing. But still you have no shelter should it be required. Therefore you see the bell-tent is not sufficient, because it cannot always be had

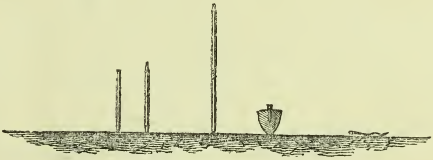






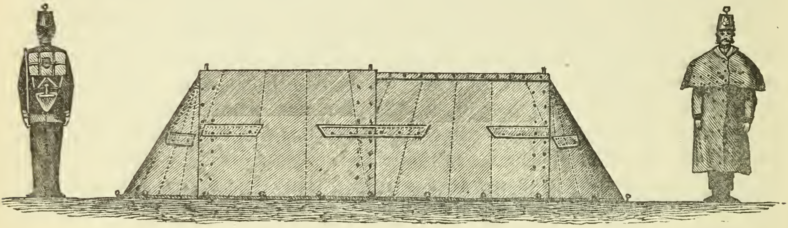
when it is wanted; and, as I have said before, it is not economical. I now undertake to do away with the bell-tent as it stood, and to substitute another from its materials. I proceed to cut the two ends; to cut off its head; and I then take the four sides, and I make what the French call a *tent d'ábri.* I know that there is a prejudice against shelter-tents, although they have never been used in the British Army, except on one occasion, when they were used by General Eyre's division in the Crimea, as an experiment. They are objected to in consequence of the weight, &c. But I think you will agree with me, that if I can undertake that this shelter-tent shall be every bit as comfortable as the bell-tent (taking into consideration the time the men must be without tents) that, as a matter of economy and efficiency, it will be a very good substitute. With regard to the question of cost; my proposed "shelter-tent," taken out of the "bell-tent," will only cost a trifle, because you have the canvas already; you have merely to cut it in the way I have shown, to fit buttons and button-holes, and cut two slits. I calculate the cost to be about 12*s.* for the whole tent. The carriage of it costs nothing, because the men carry it themselves. Every man carries a piece; and as regards the comfort of it, you will agree with me that a tent of some sort is better than no tent at all, because, as in the case of the bell-tent, the men are often obliged to do without it at all.

I now come to the question of "entrenching tools," an answer to which is the great want of our times. This also is really a question of shelter. Now there are two kinds of shelter; shelter from the weather, and shelter from the missiles of the enemy. I provide entrenching tools for this second form of shelter. Having got the poles for the shelter tent, I fit them with tools for entrenching. These tools consist of a spade and a pickaxe. Possibly, gentlemen connected with the Army, who know what the present entrenching tools are, will say that my plan is impossible. I think the contrary. My object is, that not only the tent should be carried by the men, but the tools also; because if the tools are carried in carts, the men may have to wait for them when they most need them to throw up cover, and may suffer seriously in consequence. Here I show a spade, a shovel, and a pick. This is the regulation shovel, this is the regulation pick, only reduced to a weight and size so that they can be carried by the men. I use the tent-poles as handles for the tools. The question of fixing them may appear a difficulty, but there is no real difficulty in the matter. The upper pole of the tent I fix into the shovel with a bolt, and it is quite strong enough for the purpose. The pick is put over the end of the



other pole, which is rather thicker at one end, in the usual way of picks, and it can be taken off when required.

Now, with regard to the weight which the soldier will have to carry, I find on looking into that admirable book by Sir Garnet Wolsey, "*The Soldier's Pocket Book*," that the weight for the British soldier to carry has been reduced to 40 lbs. 9 oz.; this does not include the blanket, which has to be carried for the men. My plan is to do away with carriages altogether; not to have a single cart or horse; but I cannot do without the men's blankets, the men must have their blankets. I therefore do away with the great coat, and I convert these half-canvas tents into great coats for the men. Now, each piece of canvas weighs 4 lbs. as compared with the coat which weighs 5 lbs. 14½ oz. I acknowledge that the warmth of the canvas is not equal to that of the great coat; but, as I allow a blanket, I think the two together will pretty well balance the warmth of the great coat. I thus take away 5 lbs. 14½ oz. from the weight of the kit, and I put in exchange 4 lbs.; therefore, I make the kit lighter by 1 lb. 14½ ozs. The men, however, have to carry the tent poles and the entrenching tools. The tent pole is about 1 lb.; the entrenching tools should not be more than 3 lbs. at the outside; I hope to get them less. This addition will make the kit about 3 lbs. more than the present weight. Then, again, the kit includes 70 rounds of ammunition; but if you provide the men with entrenching tools, with the means of throwing up shelter against the fire of the enemy, so much ammunition will not be required, and you may reduce the ammunition by 20 rounds, which weighs 2 lbs. In that way I get my kit down to the amount that the soldier at present carries, about 40 lbs. 9 ozs., but with the blanket in addition, which, on a short expedition, can be balanced by leaving out the extra pair of boots at present carried by the soldier. In conclusion, I may state that the cost of the carriage of the bell tents and entrenching tools for a regiment 800 strong, is about £4 per day, making for a three weeks' manœuvring about £80. Now, the cost of converting 100 bell tents at 12*s*. each, and 302 entrenching tools (the number at present allowed to a regiment) at 1*s*. each, would be £76. Therefore my plan shows an immediate saving of £4, and in future the entire cost of carriage would be saved, besides conferring, in my estimation, an immense benefit on the soldier.



Present field kit.	Weight.	
	lbs.	oz.
Valise and straps	3	1
Pouches	1	11
Waistbelt and frog	0	14
Ammunition (70 rounds)	7	5
Rifle	9	0¾
Bayonet	0	13½
Scabbard	0	4½
Knife and lanyard	0	5
Water bottle	3	10
Mess tin	1	5½
Great coat	5	14½
1 shirt	1	1½
1 pair of socks	0	4½
Towel	0	8
Spoon	0	1¾
Comb	0	0½
Brush	0	3½
Pot of grease	0	4
Housewife	0	3
Sponge	0	0½
Boots	3	3
Glengarry cap	0	4
Account book	0	2
	40	9

Proposed by Lieutenant James.	Weight.	
	lbs.	oz.
Valise and straps	3	1
Pouches	1	11
Waistbelt and frog	0	14
Ammunition (50 rounds)	5	3
Rifle	9	0¾
Bayonet	0	13½
Scabbard	0	4½
Knife and lanyard	0	5
Water bottle	3	10
Mess tin	1	5½
Tool and handle	4	0
Share of tent	4	0
1 shirt	1	1½
1 pair of socks	0	4½
Towel	0	8
Spoon	0	1¾
Comb	0	0½
Blanket	4	0
Glengarry cap	0	4
Total	40	8½
3 days' provisions	7	8
Grand total	48	0½

No. of men.	Number of men to shelter tent, articles, and weight carried by each.	Weight.	
		lbs.	oz.
1.	Portion of tent, 1 blanket, ammunition (50 rounds), accoutrements, water bottle, pickaxe and handle, valise packed, three days' provisions, rifle, bayonet, scabbard, mess tin	48	0½
2.	Portion of tent, 1 blanket, ammunition (50 rounds), accoutrements, water bottle, shovel and handle, valise packed, three days' provisions, rifle, bayonet, scabbard, mess tin	48	0½
3.	Portion of tent, 1 blanket, ammunition (50 rounds), water bottle, accoutrements, pickaxe and handle, valise packed, three days' provisions, rifle, bayonet, scabbard, mess tin	48	0½
4.	Portion of tent, 1 blanket, ammunition (50 rounds), accoutrements, water-bottle, shovel and handle, valise packed, three days' provisions, rifle, bayonet, scabbard, mess tin	48	0½
5.	Portion of tent (end), 1 blanket, ammunition (50 rounds), accoutrements, water-bottle, hatchet and handle, valise packed, three days' provisions, rifle, bayonet, scabbard, mess tin, spare grease, 1 lb.	48	0½
6.	Portion of tent (end), 1 blanket, ammunition (50 rounds), accoutrements, water-bottle, hatchet and handle, valise packed, three days' provisions, rifle, bayonet, scabbard, mess tin, 2 brushes, 2 housewives, 2 sponges, 1 lb.	48	0½
7.	Waterproof sheet, 1 blanket, ammunition (90 rounds), accoutrements, water-bottle, valise packed, three days' provisions, rifle, bayonet, scabbard, mess tin	48	0½
8.	Waterproof sheet, 1 blanket, ammunition (50 rounds), accoutrements, water-bottle, valise packed, three days' provisions, rifle, bayonet, scabbard, mess tin, camp kettle, 3⅜ lbs.	48	0½

The CHAIRMAN: Would any gentleman like to ask any questions or to make any remarks?

Captain COLOMB, R.N.: I wish to ask whether the lecturer intends to substitute his *tent d'abri* entirely for the bell tent?

Mr. JAMES: I should hope not entirely. There is no necessity to make it out of the bell tent; only as we have the bell tent already, as a matter of economy I propose to utilise it in the way I have mentioned. You see it exactly fits into my plan, although not intended to do so originally.

A VISITOR: Is it intended that the soldier should carry his tools with his tent?

Mr. JAMES: There are entrenching tools at present provided, which are carried in a cart, and the carriage of those entrenching tools comes to about a guinea a day. My plan is for the soldier to carry his own entrenching tools, not only because it is more economical, but because it is more efficient. When they are carried in a waggon you do not know where they may be. Being obliged to carry two poles for the *tent d'abri*, I utilise them as handles for the entrenching tools. These tools have been tried, and a similar system (I will not say the very exact plan) to this has been tried; but I have used a spade of this sort, and found it to answer. The weight is a little more than I should like it to be.

The CHAIRMAN: Is your *tent d'abri* about the size of the French tent?

Mr. JAMES: Yes, two of the square pieces without ends are. The French tent is open.

The CHAIRMAN: How many men will your tent hold?

Mr. JAMES: This, with the addition of two more centre pieces, accommodates eight men. The eight men who occupy this shelter tent require no carriage of any sort, neither horse nor cart. Though I cannot undertake that they should carry the tent and tools through a whole campaign, yet for the autumn manœuvres by this system there would be no expense of carriage at all.

A VISITOR: In the event of one of the men meeting with a casualty, what then?

Mr. JAMES: Unfortunately, in that case it is impossible for me to tell. But the two ends form a tent for two, and the two centre pieces form a tent for two without the ends, like the French tent exactly. My plan provides a tent for eight, five, or two men.

Commander GILMORE, R.N.: I would ask a question as a mechanic. The strength of a thing is not stronger than its weakest part. Supposing one man breaks down, the man who carries the centre part?

Mr. JAMES: Then, of course, the tent can be used as a tent for five, or for two, or for eight.

Captain GILMORE: Would the connecting parts be buttoned?

Mr. JAMES: Yes, buttoned together. Here is a tent for five, here is a tent for eight, and putting these two ends together, it is capable of holding two, being six feet in diameter.

Captain GILMORE: Would it not be equally well for the man who carries this tent to put his back against the wind, and spread his portable clothes over him?

Mr. JAMES: He can spread his tent over him if he likes. I do not want the man to get under the tent if he does not like; but what I say is this, here is a tent for him if he likes to use it.

A VISITOR: Supposing a man has to go on sentry, what is he to do without a great coat?

Mr. JAMES: He can put on this portion of the tent, which acts as a great coat.

The VISITOR: Then the tent would be incomplete.

Mr. JAMES: Then five men can make use of the remaining parts, and fix a tent for five.

The CHAIRMAN: I beg to tender the thanks of the meeting to Mr. James for this explanation of his system.

H.M. SHIP "AGINCOURT" ON, AND OFF, THE PEARL ROCK.

By Commander R. H. Boyle, R.N.

The circumstances connected with the grounding of Her Majesty's ship "Agincourt," on the Pearl Rock, have been spoken of as interesting to the service at large; I therefore, as a partaker in the operations, have ventured to come before you, to describe as clearly as I can the different steps taken from the time of the mishap until that happy moment when she was again afloat, and I must begin by asking your lenient judgment for my effort, which I am too well assured will fail to do justice to the event.

Before I proceed to details, let me remind you that the "Agincourt" during her commission, had borne no trifling or unimportant part in the services of the home station during the two preceding years. Indeed, I question whether before, any ship belonging to Her Majesty's Navy had attained so familiar a place on the lips of the world at large; from her cradle, to the time at which it was too hastily assumed by some casual observers that she had finished her span, and was to remain on the Pearl Rock, her movements have been watched with interest. From the day on which I saw her massy hull floated out of the dock at Liverpool, up to this very day on which I address you, she has been an object of interest,—first, as most formidable; then, as being the fastest ship of the whole Navy (she went 15·4 on her first trial); later on as carrying the Admiralty flag on two occasions in the van of a fleet, whose power was unprecedented; between those two occasions employed on an operation of great interest and responsibility, viz., the towing of the "Bermuda Dock" the most dangerous part of that voyage (this in happy combination with her sister vessel "Northumberland"); afterwards, and even now, flying the flag of an Admiral second in command of the Channel squadron: these are the landmarks of her career, and I venture to say she has become and is still likely to continue deserving of praiseworthy note.

In this description I intend entirely to confine my observations to the operations *consequent* on the ship taking the ground. To revert to the discussion which the court-martial has already decided, would be unnecessary and improper; and I will at once ask you to follow me and picture to yourselves the surprise with which we were all taken when in the middle of the forenoon of that 1st July, the stoppage of the way of the ship indicated the nature of the accident. The weather was lovely; sea perfectly smooth; the speed of the ship little more than a couple of knots; there was no shock to tell us of the occurrence; no apparent heel of the ship. Indeed, as far as feeling was concerned, there was nothing to tell the tale, save as we afterwards heard from a couple of stokers employed in closing the man-hole doors into the double bottom under the stoke-hole, and these men, employed immediately above where she struck, felt the grating of the ship taking the rock, and experienced some small shock.

On deck, as I say, those in charge, at once observed the stoppage of the ship, and the engines were stopped and reversed. The leads which at the time were going in both chains, were cast to see what soundings could be got; without effect, however, for from the usual place of heaving no soundings could be obtained; nor was it till a cast from the starboard sheet anchor was taken, that the fact was realised that she was aground, abreast of the second mast, at about one-third of her length from forward. There 24 feet of soundings were obtained. The want of soundings elsewhere, showed that it was on a rock she had struck, and her draught of water of 26 feet 8 inches forward, and 27 feet 10 inches aft, made us aware that though the shock had been slight, yet it was not unlikely to be tough work to get her off.

No time was lost. The first step was to warn the next ship astern, the "Warrior," to sheer out of danger. Meanwhile, the signal was made to Vice-Admiral commanding "Am Aground," and the "Hercules" was at once ordered to close, and tender us all the assistance necessary. The boats of the squadron in company were ordered to be hoisted out and sent to us, and the Admiral himself was amongst the first who were on board the "Agincourt." Signals were also made to the "Inconstant" (left at Gibraltar, where she was awaiting the flying squadron), which acquainted the Captain of the port with the accident, and cautioned him of the necessary steps to be taken. Shortly the squadron were ordered to anchor in Gretores Bay, and thus the "Warrior," "Monarch," "Northumberland," and "Minotaur" were within easy reach, and the "Hercules" at hand for towing purposes. The engines were moving astern at full speed; more boilers were lighted; and when a breeze sprung up about 11.30 a.m., sail was set aback.

The "Hercules," deterred by the tide from approaching us in the way best calculated to take our towing cables in, approached us with her bow towards our stern, and consequently a long drift was between the two parts to which the cables were directed. An 18½ hemp sheet-cable was sent from our starboard stern-hawse to her stern, and was secured, and the launches of the squadron were sent under our stern to carry the bight of the chain-sheet, the end of which was bent to a 9-inch hawser from the "Hercules" to her. That ship had meanwhile drifted further from us, and while engaged in this operation the only accident which occurred during the series of operations, took place. The long drift of cable caused our control of it to give way, and, slipping through the ring stoppers and lashings securing it, it took charge, and slipping or parting from the other boats, capsized the "Monarch's" launch, fortunately with no further ill result than an annoying wetting for the crew, and damage to the boat. Coming then with full strain on the hawser with which the "Hercules" was hauling it in, that to our chagrin, but hardly to our surprise, parted, and therefore the hemp cable was thus far the only attachment of the two ships.

High water was at hand, and there was no time then to take a cable across; so it was determined to try whether the hemp cable would be sufficient, acting with our own engines and sail power. Not so, however, for almost at the first strain it parted, and we were thus able to realise how hard and fast the rock held us. Then began the work of clearing, a work which from that time was carried on until the ship was once more afloat.

The tide, which caused a rise and fall of about 2 feet, was taken advantage of, and it was at the top of high water that the successive efforts were made, whether by anchors laid astern, by steaming, or by towing.

I may here also ask you to mark the stages of our labour, which was carried on through Saturday, Sunday, Monday, and until the afternoon of Tuesday, when she floated. Thus far I have, of course, spoken of Saturday. On the afternoon of that day, the shot, shell, and powder were got out, partly into the "Pigeon" gunboat, partly into lighters. The starting of coal was also at once begun, into lighters first; but so much sea was there alongside, that it was necessary to start them overboard for part of the time. Guns were transported aft during that night and evening, and chain cables ranged abaft, in readiness either for towing or for a stern anchor. Provisions were being got up and out, and at midnight when it was again high water, full speed astern was again tried, without any effect however. The next day, Sunday, the highest tide was expected, and in anticipation of this the "Hercules" had dropped a bower anchor, and passed the cable to us. The stream chain was used by us to heave this in, and it was brought to the after capstan. When this anchor came to be hove upon, however, a sandy bottom prevented its holding in, and it came home. On Sunday night an anchor was placed on our port bow, and a hemp sheet passed in on upper deck, and hove taut; this was to prevent the ship swinging with her head any further in-shore. On this day also, it was found that pivoting round, the ship had grounded under the engines on the port side, and hung there about one-third further aft. In consequence the strain was taken off, greatly or in part, from the starboard side, but the first warning we had of the change of position was the noise of the straining beneath the after cylinder, where the outer bottom was started in, the transverse frame borne upwards, and the joinings of plating in the inner skin started.

Measures were at once taken to shore down these plates. A sheet of india-rubber, with a coating of cement beneath, was put over the crack, and baulks of timber placed and wedged on top of this beneath the cylinder. The compartment of double bottom, which was thus bilged, was capable of holding about 150 tons of water, and to that extent water was necessarily admitted to the ship, but kept confined to this water space. As a proof of the size of the crack through which the water was admitted to this space, I may mention the fact that a fish, the size of a large sardine and of the rock cod species, was drawn into and afterwards found in the double bottom.

Coals and stores continued to be started and removed throughout Sunday night, and on Monday morning the hoisting out of the guns, carriages, and slides began.

The anchors and cables, with the exception of one sheet, were removed during that day by a party from the "Hercules," the guns, &c., by our own ship's company, aided, right loyally, by working parties of fifty men from four ships of the squadron, who had come on board the previous evening. On that day seventeen guns, with their carriages, and most of the slides were hoisted out, while at all other points, working parties were engaged in removal of all stores of every description; and while on deck a sufficiency were working the gun purchases, others were transporting and placing the guns, others hoisting coals from each of the twenty bunker-shoots along the deck and removing them to the port, anchors were being placed in lighters, cables being ranged and payed out, spars were got overboard, and later in the day when it was found that water had appeared in the bread room and slop room, which were situated in the compartment next abaft the engine-room, pumping parties had to be sent down to free those places of water and to clear them. Picture to yourselves, then, the craft, of whose condition so hapless a picture was drawn by Mr. Bland, whose letters, addressed to an anxious nation through the newspapers, placed us all unknowingly at the bar of public opinion.

Working by watches through the night of Monday, Tuesday broke upon us anxious, but confident that our labours were to be successful.

The "Hercules" was, after some trouble, enabled to place herself close enough to pass the chain cables from her stern to ours, using a large lighter to carry the end across. She had previously to weigh the anchor which had been used by us astern, and having after that let go her anchor at some distance off, backed into our stern, so closely indeed as to smash some of our stern work, but that, of course, mattered little when the object was so important, and the end so well attained.

During that forenoon we continued to hoist guns out, and here I may draw your attention to the paucity of lighters for this heavy work. Most of the vessels were coal lighters of slight scantling and in a shaky state, and had it not been for a good bedding of coal to land them on, we should have felt much hesitation in attempting to do so. One large and more strongly built craft we had, and indeed I hardly know what we should have done without her; and I may here point out that the lighter I mention belonged to Mr. Bland. It was upwards of 100 tons burden, and of much stouter scantling than the others, and carried six or seven guns with their carriages and slides easily.

Into some mud-flats with hinge-bottoms we had absolutely to put the guns, and I cannot tell you how glad I was to hear that these craft reached the mole in safety, without either depositing their present cargo at the bottom after their usual fashion, or from an endangered stability arising from a high placing of the weights, turning over in their somewhat long transit to Gibraltar.

The aid of our most admirable ally, the "steam capstan," deserves a mention here; but for it I am convinced that we should have had to wait a much longer time between each hoist of guns; but with a 6-inch messenger, or rather pendant, round it, there was a stern persuasion about it when applied to a 12-ton gun with its extra weight of carriage and slide which would not be denied. You who know the infinite obstructions which the deck of a ship now presents with the present system of racers, can realise how we had some labour to get the monster weights transported about, and the watchwords were "Go ahead, or astern!" "Stop her!" "More soap!" "Where's the Jack?" &c., these last two somewhat mysterious appeals relating, firstly, to the soft soap which was found indispensable for the transport (it was sprinkled in front of the advancing gun, whose front part of slide was on a chock, rear, on trucks), and the "Jack" related to the hydraulic jacks which for all varieties of lifting were absolutely indispensable.

That last forenoon, besides other weights, we got out five more guns, and a good number of carriages and slides, two of the guns being 12-ton. When we ceased getting weights out at noon, there was little more that could have been done to lighten the ship. Six more guns with their carriages were on the main deck, the topmast and topsail yards were aloft, one anchor and rather more than a cable were left to us, two boilers only were filled, the others having been blown out some time back, and there was a small weight comparatively of Officers' baggage, none of which had been got out—altogether hardly more than 200 tons of gear.

And now, before I go on to speak of the final and successful effort, let me glance for a moment at the engine-room arrangements; and first let me say that the exertions of all concerned in this particular department were beyond any praise which I can venture to offer.

From the moment of the ship striking until that on which she was again afloat, there was constant labour, constant source of anxiety for those concerned in the engine-room work. Firstly, from the fear of any strain consequent on the grounding causing any of the pipes connected with boilers and machinery to start and become leaky. In the second place, from the fact that the ship was aground under the stoke hole, and there it was that danger might be apprehended. Thirdly, from the necessity of being at all times ready with steam, in the event of requiring to use the screw. And finally, when on the day following the mishap, the forcing in of the outer bottom caused the most serious alarm. Then came the climax of the Engineer's exertions.

When the creaking and groaning of the ship grinding under the engines was heard, attention was at once directed to that part, and it was soon observed that the inner skin had been started up by the pressure of the frames beneath. Several rivets had started, the butts of some of the plates had parted, and the water was making its way through.

In combination with the carpenter of the ship, the engineers at once shored these plates down, and placing india-rubber sheets and cement made of iron filings, red lead, and spun yarn, the whole was screwed into its place by jacks and shored beneath the cylinder.

The double bottom arrangement extended no further aft than the after bulkhead of engine-room, and thus it was that the water extended to store rooms beyond that compartment; and some remarks on the supposed failure of the system of construction which met my eye after the event, induce me to call attention to the fact that the only reason the leakage was not entirely confined to this one space was, that to this bulkhead were fitted sluice valves intended to run the water from the after part of the ship, in the event of leakage there, to the engine-room, where the bilge pumps of the engines could speedily pump it out.

One of these valves was found not to be tightly closed, the reason on investigation proving to be that the rod, which was a bent one and with bell-crank lever action, had become too long from constant opening and shutting. The valve, which was wedge-shaped, was thus found to be one-eighth of an inch from being home.

There were no sounding pipes to this bread room compartment, and, therefore, it was not till the bread and slops remaining in this compartment were drowned, that the leakage there was discovered. Then these places were at once cleared. The Downton pump and a fire engine were applied to pump them out, and to accelerate the operation several rivets knocked through from engine-room, which allowed the water to be run into the bilge, there to be pumped out by the engines (while the clearance went on, the water, of course, was gaining).

Let me here call your attention, too, to the trial made by the chief engineer, of the powers of the engines to keep the compartment clear. By loosening the manhole-door of the double bottom the water was allowed to run from the double bottom into the upper bilge, from which the main engines were enabled to pump it overboard. Four feet of water was admitted to the bilge, and the engines, which had been disconnected from the screw, were set to work at 40 to 45 revolutions. It was calculated that each revolution pumped out at least three-quarters of a ton. This was by injecting from the bilge, as well as by using the bilge pumps, and in ninety seconds, two feet in depth, or about 45 tons was pumped. After the trial the manhole was again closed and the water confined to the outer bottom. The engines were also used to pump the leakage out before the plate had been shored down.

The divers were employed from the outset of the operations, and on the whole their labours were most satisfactory, though they failed to observe the rock on which afterwards the ship swung—that on the port side.

Up to the time that the strain in the engine-room gave warning of the new point of danger, they had reported all clear, except at the first place of grounding—that on the starboard side. From this time, however, their reports proved most trustworthy, and their work below water, when the ship was off, was entirely successful, and could be little improved upon by the trained dockyard divers, who were sent out by the " Achilles " afterwards.

And now I will ask you to follow me in thought to the afternoon of Tuesday, when, having completed our towing arrangement, we awaited the highest point of the tide at about 3 o'clock. The work of hoisting out had been discontinued at about 1 o'clock. Lighters had been all sent away, and with the " Hercules " in tow astern, with two tugs fast on our port beam, and hawsers from starboard bow and beam, to a tug and a Spanish war steamer respectively, with everything in readiness to connect the screw below when the ship should be afloat; all, from the Vice-Admiral to the smallest boy, awaited with interest the result of this which we all felt to be *the* grand effort. The hemp cable fast to an anchor laid out on the port bow, for the purpose of preventing the ship swinging more, had men stationed by it with keen axes, ready to cut, at the first signal. The main-deck was cleared of men to be out of harms way, if either of the chains by which "Hercules" had us in tow should part. I will here point out the securing of these chains, which was as in anchoring by the stern, bitted abaft and along the deck to the cable locker, where the compressors were housed taut; and at every bolt along the deck, deck stoppers were passed sufficiently tight; outside they were crossed between "Hercules'" stern and our own. Immediately before high water, the ship was lightened by pumping with the main engines, and as the Admiral was notified by the time, the signal was given by a preconcerted arrangement of flags. Men held their breath, and if they could catch sight of any fixed object beyond the ship, watched it to see whether its bearing altered; the steamers tugged their best, and the frantic gestures of delight of the captain of a tug laying off, conveyed to me the conviction that we were once again free. How can I picture, in my feeble language, the change on the countenance of that varied throng on the "Agincourt's" upper-deck at that moment. From "ardent hope" was evolved "delighted conviction," and he must have been an iron-hearted man who could fail on that moment to re-echo the British cheer which rose from the men in the ships at hand, as they saw us go with a "scend" off the rock. Action was again necessary; this we realised, when the noise of our own stern and the "Hercules" coming into collision showed that she had not been able to weigh her anchor in time to get out of our way; the bights of the cables hung around her screw, and to prevent fouling that, she slipped her ends and was soon able to trip her anchor and get out of our way. The tugs meanwhile, through some error in judgment, slipped their hawsers, and for a short time the "Agincourt," freed from the rock, was floating with her screw disabled, from the cables hanging around, and as it turned out, foul of it, otherwise it would have at once been connected. There was but one anchor on board, the port sheet, and upwards of 30 fathoms water to drop it in. Fortunately the necessity for doing so was avoided, by a tug at last closing and getting hold once again, and by the help of two of these craft, we were enabled to get to Getores Bay, where the remainder of the squadron had anchored, and where we at once began to re-ship the anchors and cables.

Before proceeding further, I will mention that in the event of this last attempt having been unsuccessful, the "Inconstant" had been ordered, and had prepared two anchors (one to back the other), which were to be dropped astern, and hove upon by ourselves—of course they were most fortunately not required; but I mention this, to show that precautions were used, and anticipations of non-success prepared for by those in charge of the operations. I believe also, that in the event of camels being required, certain vessels had been offered, and examined, to judge of their power and fitness.

The whole of the ensuing day was consumed in the attempts to clear the screw, which, being four-bladed, had caught and entwined the cables about it in a most puzzling way; and it was not till six o'clock that evening that the divers were enabled to conduct their operations to a successful close, and the ends were got in.

During that day too, another party of divers were employed in closing the crack in the plates beneath engine-room: cement prepared in the way I have before mentioned was sent down, and the engines pumping at the same time—the suction caused the composition to be drawn in, and after a short time the ship was made perfectly water-tight. On the following day (Thursday) the squadron weighed and stood across to the Gibraltar anchorage, and the "Agincourt" at once went alongside the Mole, and began the work of re-shipping her armament and stores. I think you will agree with me that in this work no time was lost, when I tell you that by Saturday at noon the whole of the guns and stores got out were again in, with the exception of the coals, and that there was nothing to have prevented her taking the sea at once. So confident were all who had seen her powers so fully tested on the rock, in the excellence of her construction and the means taken to stop the leak, that there was no one who would have hesitated for one moment to have gone anywhere in her.

The guns which had been landed at the dockyard had to be embarked again and towed alongside, and hoisted in. In 10 working hours on the first day, sixteen guns of 6½ tons, with their carriages and slides were hoisted in, mounted and transported to their places; and on the following days the remainder (two of them 12-tons) were got in, and by that afternoon we were able to wash away some part of the shrouding of coal dust which had surrounded us for so many days past, and enjoy on the following day, what I may fairly call, a well-earned rest.

But let me not forget to notice, now, the labours of the armourers of the squadron, who were sent to replace the gun-gear and fittings, which required mechanical knowledge. So admirably was their work performed under the supervision of our gunnery staff, that it elicited the spontaneous testimony of the Gun-wharf officials at Devonport on our return, who in a formal letter to the Commander-in-Chief of that port, stated that no ship had ever come into harbour with her guns and gun-gear in such perfect order as the "Agincourt," which they had just examined. And again, I may mention, that amongst the manifold parts of machinery, which constitutes gun-gear in the present day, and all of which was passed into lighters and sent away, there were but a few of the most trifling articles deficient; and this speaks volumes for the care with which the strange working parties, on whom fell the task of clearing the lighters on shore, fulfilled their duty.

When the "Valorous," which had been despatched with Mr. Angear as master-shipwright, from Keyham, and a staff of shipwrights, divers, &c., arrived, she found the object of her quest almost ready for sea again, and though their services were very great in repairing the damages due to our collision with "Hercules," matters of no *vital* importance, however, they found little to be done in the way of strengthening that which had been already done before their arrival. The "Achilles" which had been ordered to ship timber and other stores for the purpose of strengthening vessels, for camels to assist us, was stopped on the eve of her start from Plymouth, by the news of our being afloat; a practical answer to the letter which it was understood Mr. Marcus Bland had written to the Admiralty to say, that "if they wanted to "get the ship afloat again, some one must be sent out who knew what "to do." And this brings me to the subject of the attack published in the *Times* and other daily papers by that individual; an attack which I may point out never came to our notice until our arrival in England, a fortnight or more after its publication. Most, if not all of you, read the letter in question, and some of you may have wondered that the reply to it was not forthcoming, and that what bore on its face so serious a charge should have been unanswered in the principal organ which gave it publication. I can tell you the reason. When at the time of our return to England, our eyes first met the letter in question, you may imagine our indignation, and easily picture the impulse of certain of our number, who would have sat down and given vent to their feelings. With a court martial at hand, where it was presumed all the evidence connected, not alone with the stranding of the ship, but also with her getting off, would be elicited, it was thought better to moderate their ardour, and letters were withheld until the sentence had been delivered. You know that that court martial did not think fit to make any inquiry into these matters, and therefore no public vindication could be entered before them, and it was then that individuals turned to the *Times*, the paper which had given an importance to Mr. Bland's letter, by its publication in conspicuous type; and there I regret to say it was that they met with the obscurity of the waste paper basket. I cannot—I think the verdict of my hearers generally would be, "I need not"—attempt to explain away Mr. Bland's statements. I have seen in no other quarter, have heard nowhere, anything to lead me to believe that the Officers and men who worked on board the "Agincourt" are credited with disorder, incompetence, or any of the other defects which were then assigned to them, and I can certainly call to mind statements, both from public speakers and writers, who have distinctly indicated the contrary belief.

One or two points in conclusion, and I will not trespass further on your patience.

1st. The want of proper stern-hawse-pipes (in addition to towing chocks, which bolted into the stern-ports) was most noticeable. Most of the other ships have such pipes. The result of our heaving stern cables over the chocks was that the iron casing cracked, and the edges broke off, and great damage was done to hawsers and ropes which had to be used in those chocks afterwards.

2nd. The utter futility of using hemp cables for one of these monstrous iron-clads, whose weight alone is equal to 10,000 tons; it was only used in our case, because of the accident to the chain cable which I have mentioned.

3rd. That for the cable working arrangements in the stern, the fittings of these large vessels are inadequate. There was absolutely no means of controlling the cable in paying out, other than of lashing by fleets, and cutting the lashings in turn—surely a most tedious method—ring stoppers were of little value for a chain of 2⅝ iron, which weighed 33 cwt. each length.

4th. The creditable test which the ship's frame underwent while on the rock—the enormous weight of nearly 10,000 tons—2 to 4 feet above its proper flotation, resting but on one point of that frame not more than 8 feet by 3 feet. Yet on examination afterwards in dock, there was no sign of deflection about any part of her, except where the rocks had made their indentations; and these, let me add, were so slight that there was absolutely nothing to have prevented the ship going to sea without repair, and it is my belief that but for the toughness of the iron of the starboard bilge keel, which was wrenched and got athwart ships, the ship would have come off on the first day, but this keel acted as a sort of toggle, and held her firmly.

5th. The success with which the divers trained in the service, conducted their operations. They were afterwards assisted by dockyard divers, but there was no necessity for such aid. What an advantage it would be for Officers to have a practical knowledge of diving, was proved most clearly. All through the anxious time I have taken you thus hastily, the report of an Officer would have often explained discrepancies in those of the seamen divers, who were on certain points of their reports at issue, and sometimes puzzled us folk above water. More particularly was this the case when clearing the cables which had fouled the screw. The screw had revolved after the cables struck it, and being four-bladed the bights were entwined to a most puzzling extent around the boss—necessitating unshackling below water, and the consequent hanging of parts, by hawsers bent and shackled, also below water.

6th. The gallant efforts of two engineer Officers and a leading stoker, who made their way through the intricacies of the inner bottom to the place where the leak was, in order that they might examine it; to do this, they had to crawl through man-holes in the framing, nine in number, I think, and all the time in water, which the pumps were working at to keep down. Fancy short dives through manholes under water![*]

7th. The cement called after our chief engineer "Patterson's Particular," which though known pretty well under other conditions, and used often enough elsewhere, was used here first, I believe, for stopping a leak under water in an iron ship. I believe that Mr. Angear, the dockyard Officer sent out to aid us, placed small faith in its lasting powers, but I can answer for it that for some days it kept the ship quite tight.

8th. The necessity for an extension of the 40-horse power donkey pump suction to enable the double bottom to be pumped out readily by it. By the present arrangement it is led under fore stoke hole and requires 12 inches of water in the double bottom to cover the suction. With the ship 18 inches by the stern, this meant the presence of a large

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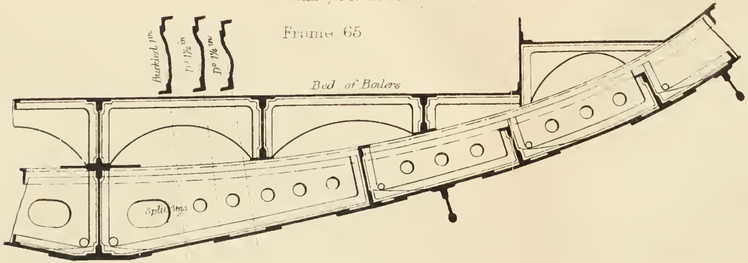
[*] I am sure you will think their names are worthy of record, and I beg to give them: Messrs. Boyd and Coope and Leading Stoker Murray.

"AGINCOURT" Sketch shewing the damage occasioned to the Frame Plates on the Starboard side by the Ship taking the Ground.

Scale 3/16 of an Inch to a Foot

Frame 65



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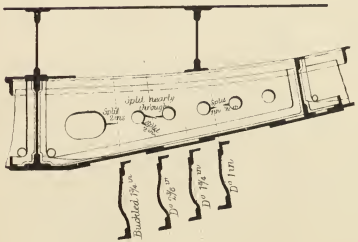

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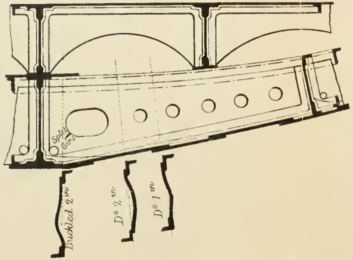

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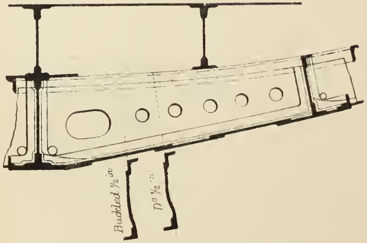

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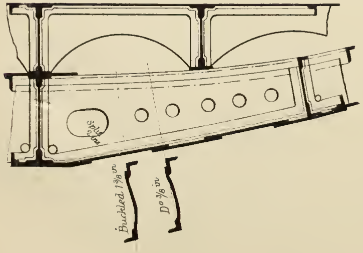

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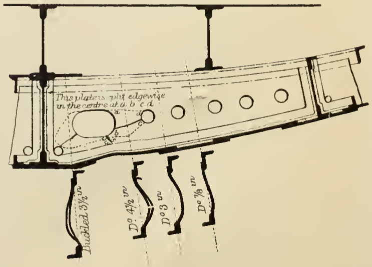

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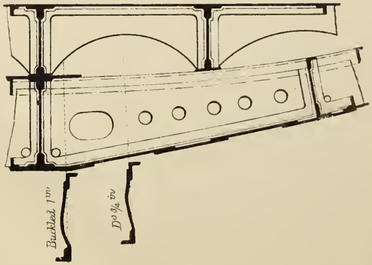
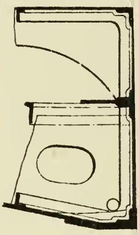
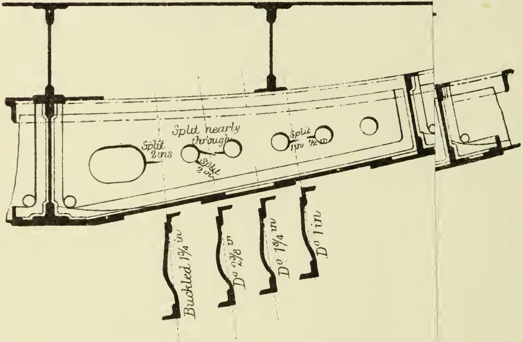


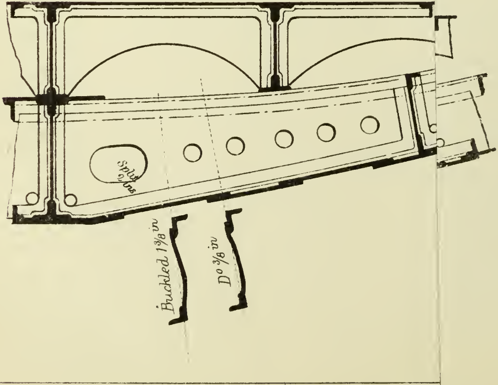
"AGINCOURT" S



Frame 66.



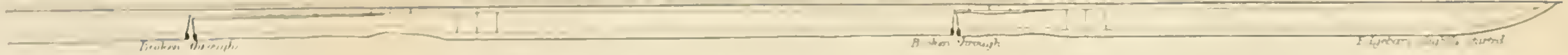
Frame 69.



J Jobbins

Sketch showing the nature and extent of the damage occasioned to the bottom plating &c. on the starboard side of the ship by taking the ground

Longitudinal view of the lower bilge keel on the starboard side in wake of the Second Mast



Expansion of the keel and bottom plating on the starboard side of the Ship in wake of 2nd Mast

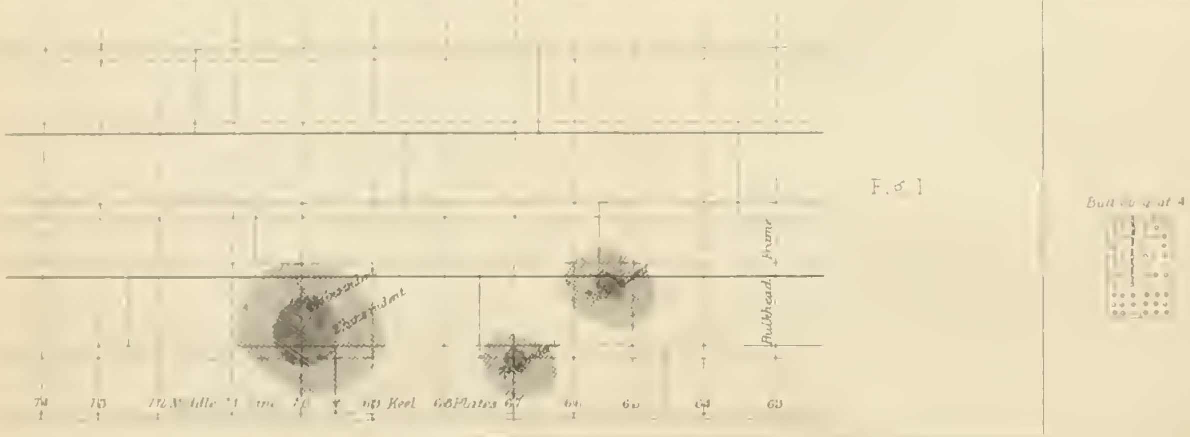


Fig 1

Fore and Aft Elevation of Lower Bilge Keel

Expansion of Bottom Plating

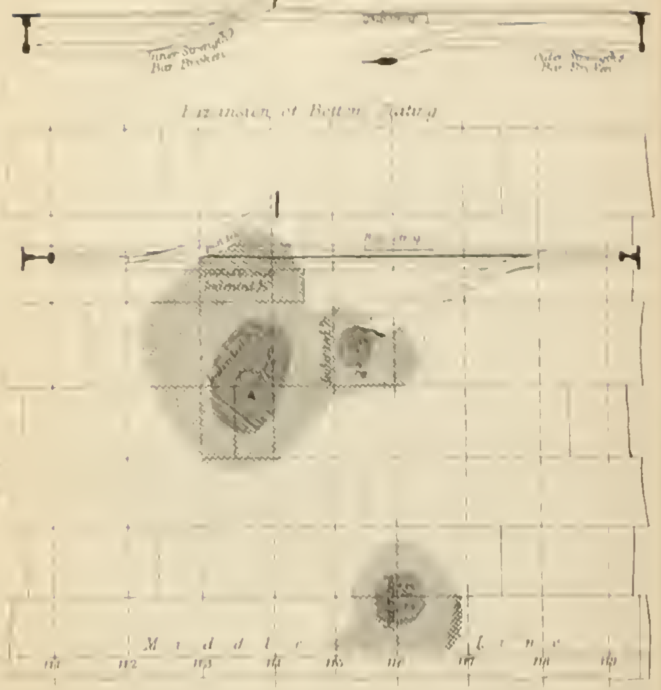


Fig 2

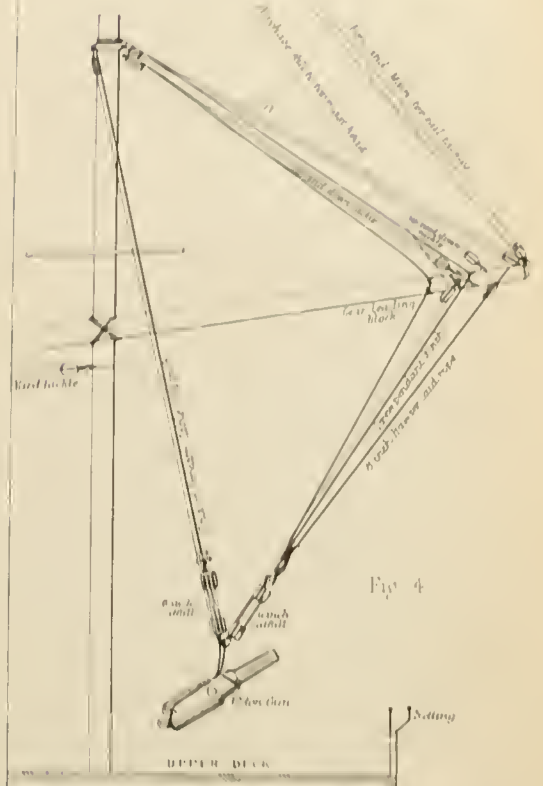
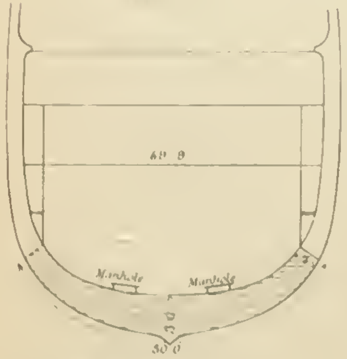


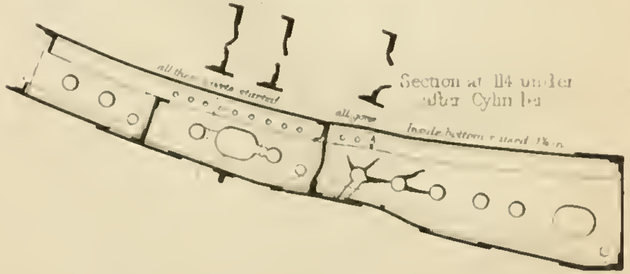
Fig 4

N.B. Tackle was hooked to upper block of stay purchase to plumb the hatchway; for this the Boats stay was brought aft from the mast before it.
For hoisting out the yard was not slewed but while hoisting in the forward yard was used beneath it a forward tackle to opposite lower yard arm to steady it from topmast head, ... yard tackle was used for rolling tackle.
Lashing of yard was 4 inch rope, as also those of the pendants to the yard.

Fig 3

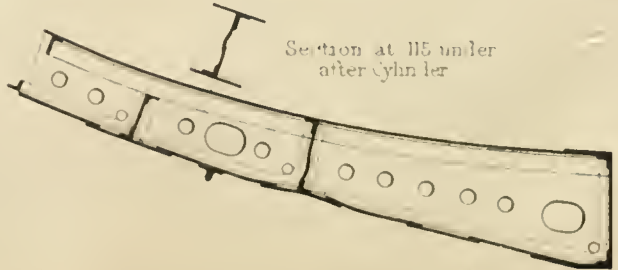


Mean height between bottoms	2	6
Length of Engine room	37	6
Length of Arch say	50	0
Weight of water in compartment	135 tons	

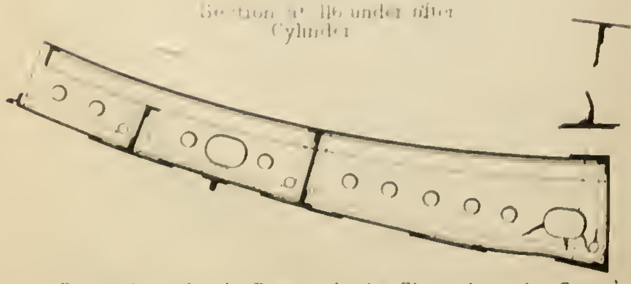


Section at 114 under after Cylinder

Section at 115 under after Cylinder



Section at 116 under after Cylinder



Sketch showing the damage occasioned to the Frame & bottom plating on the Port side under the Engines by the Ship taking the Ground

J. Jobbins

quantity of water in the ship, larger than we at any time allowed to remain.

9th. The reserve of pumping power which was held in the engine-room, and which I have pointed out already; with such engines I cannot conceive a ship foundering if able to use her steam at all; with the screw disconnected, they were perfectly in hand.

10th. The want of a good system of pauls, or better still a serviceable *break*, for the steam capstan. This crying want, which is a slur on our service, should not be allowed to continue. The objection to the common pauls is that they are liable to be thrown down off the pin when out of gear, and before being noticed, break down the engine or injure the paul-plate. An attempt at a break, which was fitted to the "Agincourt's" capstan, was an utter failure. I suggest the application of a band at the capstan head. Surely our mechanical skill in the Navy will shortly supply this want.

The great advantage which might be gained in these monstrous ships by some means of readily detaching the enormous weight of iron-armour with which their sides are clad, is obvious, and deserves consideration. On the "Agincourt's" side were 1,700 tons, to start which in part, would have taken many days with full appliances, and under the present condition of fitment, their removal is practically impossible; that is, within any reasonable time.

Finally, let me wish that on the day—far distant may it be!—that any of you, my hearers, are in similar circumstances of difficulty, you may have as directors and helpers, Officers as determined and ready-witted, —men as loyal and hardworking as those who, whether belonging to the "Agincourt" or the remainder of the squadron, saw their efforts crowned with success on that 4th of July.

WEIGHTS HOISTED OUT.—*Approximate.*

Shot, shell, and powder	200 tons.
Guns, carriage, and slides	300 „
Coals	400 „
Anchors and cables	120 „
Boats, sails, W.O. stores, &c.	130 „
Provisions and water	150 „
Total	1300 tons.

38 tons for the inch at load draught.

	Forward.	Aft.
Draught before taking the ground ..	26·8	27·10
Draught after coming off	23·11	27·10

Lightened 2 feet 9 inches.

Each boiler held 17 tons of water.

The CHAIRMAN: We shall be glad if you will explain the diagrams.

Captain BOYLE: The upper plan (see Plate ix, fig. 1) shows the indentation on the starboard side of the outer bottom. The blotches show where the points of the rocks rested. That was the main point of bearing, and there was an indentation of about three inches there; and rather less here, and here (pointing). That was the first place on which the ship grounded. Afterwards on the port side that was the most important part (see Plate, fig. 2), and that is where the fish found its way in. This line shows the line where the bilge keel went along; this curve is a broken part of the bilge keel (Fig. 2). I may here express my belief that it was the bilge keel that prevented the ship coming off the rock much sooner than she did. It was such tough iron that it caught, and curved up on both sides; the ship settled down on those two parts, and the jagged ends cut into the rock and held with great tenacity. These indentations will show you the very slight amount of damage that was done to the ship at any time. It is only shown very slightly out of line; that is the worst part; you may see that that is the actual extent of the damage (see Plate). There was no part of the frame of the ship above the bottom strained in the slightest degree. The upper deck, main deck, and lower deck, were exactly in line; there was not the slightest strain. Nor was there any strain upon any part of the engine-room pipe, which would of course have shown it as readily as most parts. This gives you an idea of the amount of water that can be let into a ship by the double bottom arrangement; it would come up to there and no further on each side (see Plate). The "Agincourt" was divided fore and aft into eleven water-tight compartments, besides the double bottom arrangement. The deepest double bottom compartment in the engine-room (see Fig. 3) held from 135 tons to 150 tons. The plan for hoisting out the guns I will explain hereafter. Of course the work was all done from our own resources. I do not pretend to say that the tackle we employed was not a great deal too strong for the theoretical allowance for weights. But when I tell you it was rigged in just as short a time as the most entirely scientific purchase could have been, and that in that way it hoisted the guns out without the slightest accident, or straining of rope or iron, I think I have said all that is necessary.

The CHAIRMAN: Does any gentleman wish to ask Captain Boyle any question?

Captain RANDOLPH, R.N.: I have not exactly caught from Captain Boyle how much less water the ship had under her than what she drew, so as to give us an estimate as to whether she was at all water-borne, or how much weight had to be removed to float her. One further question—Whether during the whole of the three days the sea was perfectly smooth?

Commander GILMORE: May I ask Captain Boyle, having been present himself and seen the indentation at the bottom from the concussion of the rocks, whether he can form any idea what the result would have been if a small torpedo had been fired in the same position? The whole question resolves itself into this, if a ship grounds on a rock without her bottom being greatly injured, what would be their degree of safety against the effects of a torpedo?

Commander W. DAWSON, R.N.: I have to thank Captain Boyle in my own name, and I am sure I may express the thanks of those present for the very able way in which he has told a very good story. He has given us all an admirable lesson in one of the highest problems of seamanship. Most of us who have served afloat for any time have had considerable experience in ships running on shore as well as in getting them off, for it is no new thing for vessels to get on shore. Though it is quite true that ships are not stranded so frequently as in former days, yet depend upon it, so long as nerve and skill are characteristic of the Navy, close shaves will be made, risks will be run, and we shall continue to hear of ships going ashore and getting off again. It is not, however, every one who has the opportunity of gaining experience in recovering one of the largest ironclads in Her Majesty's service, a ship of no less than 10,600 tons weight. We are, therefore, deeply indebted to any Officer who comes forward to give us the benefit of such experience. It is, indeed, very much to be regretted that there are no official means extant by which such valuable experience gained in the public service can be communicated to the whole Navy, so that all might learn from the experiences of the few those professional operations which all cannot have the opportunity of practising in their own persons. It is impossible to listen to a description of the recovery of the "Agincourt" without carrying one's mind back to the recovery of a sister ship in the Thames, which was described in this Institution by Admiral Sir John Hay.* On that occasion the "Northumberland" was in smooth river, in a dockyard, with the whole of the resources of that dockyard and of a number of other dockyards close at hand. Those engaged in that operation had the benefit of the experience of all the engineers and all the engineering resources in this and other countries. Notwithstanding the great skill displayed, the manifold appliances employed and the favourable nature of the locality, it took about a month to get the "Northumberland" afloat. This showed the enormous difficulties to be encountered in rescuing an ironclad of 10,600 tons weight from a perilous position on shore. All honour to those who succeeded so well in the case of the "Northumberland." But when we remember that the "Agincourt" was got off from a rock exposed to the whole Atlantic Ocean in four days by the ordinary resources of the fleet, for Gibraltar has not got the requirements for such an emergency—when we remember that the "Agincourt's" recovery was effected almost entirely by the ordinary resources of the fleet, and by the engineering skill of the officers and seamen of that fleet, without external aid or advice, we are bound to regard it as a most magnificent exhibition of modern seamanship. And we much abused modern seamen may well be proud of those distinguished officers who had the honour of getting that ship off. For my own part, I must confess that, until I heard Captain Boyle's paper, I was very much in the dark as to how it was possible to hoist out so rapidly and under such conditions, with the ship's own resources, no less than 1,300 tons of weights, including amongst them several twelve and a half-ton guns. Once explained to us, the whole operation is simple enough. It appears to have been effected by the good old devices, the principles of which were known and applied by us in former days. The several other evolutions that have been described are such as reflect great credit upon our modern seamanship and engineering skill, showing that we have not gone backwards in this particular direction, but that those who, like their professional ancestors, have the nerve and the pluck to get ships on shore, have the skill and the stamina to get them off.

Captain R. O'B. Fitzroy, R.N.: There are two points in connection with Captain Boyle's interesting paper that I think ought not to be passed over on the present occasion. That is the difficulty we all experience in modern iron-clads in securing our ships by the stern, in anchoring by the stern, and in laying out anchors of sufficient weight to be of any use to haul an iron-clad off shore. It frequently happens that an iron-clad has to go inside a mole to take in coal, like the mole at Gibraltar, or the mole at Naples. There is great difficulty in securing the springs and stern fastenings for the want of proper leads for them, and the want of proper places to secure them to. It may happen to an iron-clad—it has not happened yet—that she gets on shore without any ship near her, or the means of telegraphing for a ship to help her off. Everything must be done instantly; it must be by downright energy on the spur of the moment. Weights must be got out without any hesitation, and she must have means and ways of carrying the weights away from the ship. It is a very serious question in the present day whether a modern iron-clad has a boat of carrying capacity enough to float her heavy moveable weights; whether it would be any use laying out a bower anchor to haul a ship of the displacement of the "Agincourt" off; whether it would have the slightest effect upon her beyond checking her going further on shore; and if she had no ship near her, how she could get her weights out quick enough to lighten her and get her off. The hatchways are not sufficiently large, and ships are not supplied with sufficient purchases and leads to get heavy weights out quickly.

Captain R. Wells, R.N.: There is one statement I should like to make about the "Hercules," and I think Captain Boyle has not mentioned, that the bower anchor that was laid out, as well as the stern anchor, was not of the slightest use in moving the ship. They both partially held, but were coming home at a comparatively small strain. As to the "Hercules," I cannot help thinking but that we are much indebted to her for getting the ship off, owing to the wonderful way she was manœuvred for upwards of six hours in a strong current. Occasionally she was within 10 or 12 feet of the "Agincourt," and so near that every now and then one could have almost jumped from the poop rail of the one ship to the other. Thus, in justice to the "Hercules," some credit should be given her for the admirable handling. By a turn of the screw and keeping the ships close together, the labour of getting in the stern cables was eased, and the work much facilitated; in fact two or three hours did the work, and the attempt was made at the height of the tide the same afternoon, whereas, on the other hand, a timid man might have postponed it for a day or more.

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* "The Launch of Her Majesty's ship 'Northumberland:'" by Rear-Admiral Sir John Hay, Bart., M.P. See *Journal*, vol. xiii, page 435, *et. seq.*—Ed.

Captain COLOMB, R.N.: I wish to make two remarks. First, with reference to the fitments for carrying out the chain cables abaft, that defect is not confined to ironclads. I had occasion, in a ship I commanded in the East Indies, to feel that defect very severely after getting on shore. We found much in the same way, that there were no appliances whatever for getting a chain cable out abaft. We had to make the best of it we could, with a temporary arrangement of the heaviest baulks of timber we had in the ship. I wrote non-officially to the Admiralty about it, and I was informed then—it is nearly three years ago now—that the Admiralty had already noted the fact, and that in the new ships care was being taken to give all those fitments abaft that have been spoken of as necessary. Another point which struck me was this. Captain Boyle spoke of the failure of the sluice valve between two compartments, by which water spread from one of the so-called water-tight compartments, and filled or partially filled another one. I hardly ever heard of an iron vessel with so-called water-tight compartments getting on shore, in which there was not a defective sluice valve. I was engaged years ago in assisting to get off two iron ships, which were lost simply from the fact that their water-tight compartments when tried, turned out not to be water-tight. In the same ship that I spoke of, that I lately commanded, we had one small water-tight compartment forward. When I joined the ship I found it had been the practice to carefully work the sluice valves of this compartment every week. I had them carefully sealed up directly I got on board ship, and saw they were tight, and kept them tight the whole time. I think we shall always find wherever there is an opening from one compartment to another, which has sometimes to be open and sometimes to be shut, that it will fail in the time of danger, and that no "water-tight" compartment can be said to be so, unless it is—so to speak—hermetically sealed. I should like to ask Captain Boyle if he would roughly tell us the spars and the purchase used in getting the 12½-ton gun out; for I recollect years ago, when my friend Captain Dawson, I think, was with me, when we thought that 3½ tons was a very heavy weight to get out by the main-yard of Her Majesty's ship "Sidon." When we come to any weights, such as are described there, one would like to know exactly, for the purpose of record, what spars were found fitted for the work, what purchases, and whether the present supplies of stores are sufficient.

Admiral Sir EDWARD BELCHER: In the Royal Navy as far back as 1816 all the ships that went to Algiers were prepared with iron-plated ports for anchoring by the stern. Afterwards, in 1829, when Sir E. Owen had the "Southampton" fitted for the East Indies, the Admiralty directed that every ship should be prepared to anchor by the stern; and the "Southampton" was accordingly fitted with stern bitts. Again, in 1830, when I was ordered to fit the "Etna" for service, she was prepared with extra hawse-holes of gun-metal throughout the ship, in every direction on the upper deck, where any strain could be brought. She had them on either bow, on the quarter, and two astern. In the "Samarang" they were similarly fitted, indeed, in nearly all the ships I commanded; and I also know in the "Erebus" and "Terror," they were so fitted. It is therefore surprising to me that, knowing that these things were necessary years ago, it has not yet become the general practice in the Navy.

Captain COLOMB, R.N.: I should like to complete what I intended to have said, as it is rather an important point. It is with reference to what Captain Boyle stated about a double bottom connected in many parts, and a double bottom connected in few parts. It has been represented that in the modern double bottom, where the transverse pieces are very few and further apart than in the old plan, the new plan is the stronger of the two. I could not help thinking, while he was speaking, that he had given us something of a proof that the new plan was the right one; for, unless I misunderstood him, he described the leak in the engine-room taking place because the strain of the outer skin of the double bottom was transferred to the inner skin by their connection at that point, and some rivets were driven through. We must suppose that if there had not been transverse pieces there, that these rivets would not have been driven through.

The CHAIRMAN: I also wish to ask one or two questions. Could the "Hercules" have anchored close up to your stern, as close as when she came near you, subsequently? When you were drawn off, did the rock on the port side scrape along the bilge? did you feel it, or had the vessel been so lightened that you passed over it? What was the total weight by which the ship was lightened? If nobody else has any questions to ask, perhaps Captain Boyle will kindly answer the questions that have been asked.

Captain BOYLE: I think perhaps the last question had better be answered first, because it in some sort applies to some of the others. The weights hoisted out were approximately shot, shell, and powder, 200 tons; guns, carriages and slides, 300 tons; coals, 400 tons; anchors and cables, 120 tons; boats, sails, spars, 120 tons; provisions and water, 150 tons; total, 1,300 tons. The ship required 38 tons at low draught to be hoisted out to lighten her one inch; and she was lightened 2 ft. 9 in. in all. Each boiler held seventeen tons of water. At the time that she went on the rock, she was more than two feet out of water forward; that is to say, there were 24 feet of water on the rock, and the ship's draught was 26 ft. 8 in. forward. When she came off, her draught forward was 23 ft. 11 in., and her draught abaft the same as when she went on.* The sea was smooth that day; indeed during the whole of the time that she was on shore, there was not a very important motion, but on the second and third days there was a certain amount of swell, which caused at one time, after we had grounded on the port side, some rather serious bumping. But on the day we came off, there was no motion. With regard to the effect of a torpedo on the bottom, a question which Captain Gilmore asked, I hardly know whether I can venture to offer an opinion. I should say that the sudden shock of an explosive would have infinitely more effect than the simple settlement of a great weight on a rock; therefore, I should say that, probably, a torpedo would have done infinitely more damage, although it might have acted on a greater surface. Captain Dawson brought before us the facts connected with the "Northumberland." Of course, I looked up those facts before I came here, but I saw nothing in them in which we could trace any resemblance. The people who got the "Northumberland" off, deserve all the credit that they have gained. I cannot venture to think that we had anything like the work that they had to do. About the stern-anchor, hove upon on Sunday night, not holding, suggested by Captain Wells. It was found to have come home considerably; so they stopped heaving on it. Then it was hove up again by the "Hercules" the next morning. With regard to the credit due to the "Hercules," I can only re-echo what fell from Captain Wells, that she was most ably handled. While I am speaking about her, I am sure that I may answer Admiral Ryder's question as to the "Hercules" anchoring. It would have been useless to have anchored her at first. But what she might have done, and what I think most will agree with me who saw the operations would have been better if she had done, was to have hung her stern to ours by a hawser, some stout hawser, and so have come close to us and remained with her stern towards us, because there is no doubt it was owing to the distance that we had to pass the chain cable along her, being her own length, in addition to the space she was from us, that much unnecessary labour was performed; whereas, if she had been stern on towards us, it is obvious the distance would have been infinitely less. That is the only thing I can venture to suggest as any improvement in the conduct of the "Hercules." On the last day, nothing could be finer than the way in which she was handled. The tide was not anything like as strong on that day as it was on the previous days. Having dropped her anchor astern of us, she was able to back into our stern and to remain in position; but it was not done without very great exertion and very great ability. I question very much whether there were many people who would have been able to have done it as well. Captain Colomb laid stress on the "stern fitments." I find in the present day there is a good deal of doubt on the subject of the advantage of stern fitments for anchor work; not in this assembly, I am happy to say, but amongst a good many others, I have found there is very great doubt as to their use, and one cannot lay too much stress upon their necessity. In the matter of the sluice valves, I can hardly agree with Captain Colomb. Of course I say this with doubt. But on board a well-cared for ship, I do not see that it is likely a sluice valve, which is worked every week, and more frequently, and constantly exercised with, should get out of order. On board the "Agincourt," as on board all other large ironclad ships, certain compartments used to be closed and worked for exercise. They were actually tested, and if those sluice valves were not there, the bilge water which invariably settles in any ship, whether arising from the actual sweat which streams down the side of an iron ship, or from any leakage, would not be able to go off into the bilge and there be pumped out. I think that is a very vital point. The spars used I will come to directly. We had "stern-bitts," as Sir Edward Belcher mentions, and good ones, but we had not stern hawse-pipes; we had not sufficient bolts along the deck; and we had no controller astern, as we ought to have had, and as I say every ship ought to have for large cables. The only means we had of checking and controlling the cable from paying out suddenly, was by lashing it by fleets to the bolts that we had on the decks and cutting those fleets in turn. When you have got a boat under the stern taking the weight of the chain, this is a very ticklish thing, as you will all agree with me. When we came off, I am afraid I cannot say whether the rock scraped along our bilge. We were so glad to be off, that we did not think about what was going on below.

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* At low tide, with a fall of 2 feet, she was thus 4 feet above her proper flotation resting on the rock.

The Chairman: Can you explain why the seamen gunners who went down the port side, did not find that she was touching on that side?

Captain Boyle: The fact was I think that, although they went under the ship's bottom, their attention was directed to the starboard side. First of all, probably, they did examine all around the ship, and found her clear except on the starboard side; and when she grounded on the port side, they had made up their minds that the starboard side was the only one in risk, therefore, they did not pay so much attention to the port side. With regard to the spars used (pointing to diagram, see Plate ix, fig. 4), this is the mizen mast, the third mast, and that is the lower yard of that mast. It is an 86-foot yard.

The Chairman: Wood or iron?

Captain Boyle: Wood, cross lashed as you see it; the mast is iron; with 72 feet height of mast from mast head to the deck. First of all, when we were hoisting out the six and a-half ton gun, all we had was a nine-inch screw pennant. We had not a sufficiency of blocks to use for taking them out to the yard with. We had cross lashings for the purchase pendant, and then took the end across the lower cap down on opposite side to the deck, and set up. The stay purchase pendant was the end of a 13½-inch stream cable, which was round the lower cap, and also brought down on deck and secured.

The purchases were made with cat blocks and six inch falls, anchor shackles used to connect them with the pendants. Hauling part of the fall of yard purchase led from lower block to the yard, thence to topmast head, and on deck; that of stay purchase to the lowermast head and on deck; two sail tackles from topmast head to yard arm; two up and down tackles, lower lift, and preventer lift were the supports of the yard. On the opposite side one sail tackle from topmast head, lower and preventer lifts and yard tackle as rolling tackle.

When getting the guns in, the yard was further shored with a topsail yard, whose goose necks had been taken off, and one yard arm of which, stepped in a shoe on the deck beneath lower yard, the upper yard arm being lashed out to the lower yard close to the yard purchase.

The Chairman: I have been asked by Sir George Sartorius to ask you, supposing you had not got lighters from the shore, how would you have floated the cable?

Captain Boyle: On the last occasion, I presume our own boats would have been quite sufficient, even if it had been necessary with the "Hercules" in position. But the "Hercules'" position on the last occasion was quite close enough to have done it without any assistance whatever.

Sir George Sartorius: If you had been by yourself and no other vessel near you, had you sufficient means to float out your chain cable to lay out a stern anchor, or bow, according to circumstances?

Captain Boyle: We had a sufficiency of boats. I do not mean to say we should not have knocked them about sadly. We had thirteen boats in the ship. I do not see any difficulty in doing it if we had been put to it. We had two launches and pinnaces, two cutters, two life boats. All these boats would have been of great use in buoying a cable. Considering the smoothness of the water, I do not think there would have been much difficulty in that; if we had to lay out a stern anchor, of course, it would have taken more time than we had to spend about it, but I do not think there would have been any difficulty.

Sir George Sartorius: You must have been pulling at the same time.

The Chairman: Had you a steam launch?

Captain Boyle: We had a steam launch. We should have laid out a stream anchor first of all, to haul out the boats to position.

The Chairman: I am sure I may return your thanks to Captain Boyle for the valuable and instructive paper he has read. I have no doubt you have all heard, as I have often heard, people express their doubts as to whether an ironclad could be got off (if she got on shore), on account of the great weights in her, and the difficulty of getting rid of them. We have lately had an account of two or three ironclads getting on shore, and being got off. I hope the process of getting them off will always be as well managed as in the case of the "Agincourt."

LECTURE.

Friday, April 12th, 1872.

Colonel the Hon. CHARLES H. LINDSAY, M.P., in the Chair.

ON THE GENEVA CONVENTION OF 1864, IN RELATION TO THE AID AFFORDED BY VOLUNTEER SOCIETIES TO SICK AND WOUNDED SOLDIERS DURING THE LATE FRANCO-GERMAN WAR, WITH A GLANCE AT THE PROPER FUNCTIONS OF NATIONAL AID-SOCIETIES, PARTICULARLY THE BRITISH AID-SOCIETY, IN THE FUTURE.

By Deputy Inspector-General T. Longmore, C.B., Professor of Military Surgery at the Army Medical School, Netley; and delivered, in his unavoidable absence, by Deputy Inspector-General Maclean, C.B.

The origin of my having the honour of addressing you to-day was an accidental conversation with Captain Burgess, the excellent Secretary of this Institution, during our autumn holiday last year in Dorsetshire. Some remarks which I then made to him respecting a prevalent misapprehension of the terms of the Geneva Convention, led him to suggest that it might be of use were I to make them more widely known through an address in this theatre. I did not at that time consider the matter one of sufficient importance to occupy the time of an audience at the Royal United Service Institution, more especially as I had already attempted to explain the Articles of the Convention shortly after the Treaty was concluded; but circumstances have since changed my impressions on this point, and it now appears to me, and it has appeared to some others, including the Director-General of the Army Medical Department, that a few public remarks on the subject may probably lead to some good. I myself have been led to this conclusion from observing in various articles in the newspaper press, but more particularly in the published replies to a series of questions issued by the British National Society for Aid to the Sick and Wounded in War, sentiments very generally expressed concerning the Geneva Convention of 1864, the intended modes of applying its Articles, and the immunities and privileges agreed to be conferred by it, such as, I am well aware, were never held by those who framed the Convention, and which, indeed, cannot be substantiated by a legitimate interpretation of the Treaty itself. I mention particularly the replies to the Questions put forth by the National Aid-Society, because these replies contain the views of Officers, and others, who acted as members of the Staff of the

Society on the Continent during the late Franco-German war, and of some others who were officially engaged in reporting on the practical working of the Convention during the war, and who, therefore, of all others might be supposed to be well acquainted with the provisions of the Treaty in question, and their respective limitations. Nor are the notions, which I expect I shall presently be able to convince you are erroneous notions, regarding the Geneva Convention, of trifling importance. On the contrary, they appear from the extent to which they prevail, to be causing the Convention itself to be regarded with very great suspicion and distrust, if not to be exciting hostility against it; by these means, to be raising obstacles to its legitimate and intended action in the future, should occasion unhappily arise for its application.

As I have referred to the questions and replies published by the National Aid-Society on the results of the experiences of its Staff, I beg to be permitted to say a few words respecting the Society and its late work, before I proceed to the consideration of the special subject of to-day's lecture.

I have no intention to refer to any particular part of the work in which the Society was engaged during the war; I only wish to express an opinion of its general results. The early history of the Society, its extensive and varied operations, have already been described in this theatre by the one, who, of all others was the most competent to do so, Colonel Loyd-Lindsay;* with, however, I must say, one exception—that exception being the very important part which he himself took in its establishment, its administration, and its success. I had the honour of being present at some of the preliminary meetings of certain members of the Fraternity of St. John; and admitting all due weight to the influence of this fraternity, particularly to the exertions of two of its members, Mr. Furley and Captain C. J. Burgess, I think all will agree with me when I say that the National Aid-Society only struck root after the earnest and energetic public appeal of Colonel Loyd-Lindsay, through the medium of the "Times," supported as it was by a most generous contribution to the subscription-list which he then opened. Neither should I omit to state, as I conscientiously can do from personal observation, that it was no less to his clear-sighted direction and promptitude of action, and unceasing devotion of his time and attention to the affairs of the Society, that its continued support by the munificence of the public, was mainly attributable. Every one felt confidence in the Society, from observing the manner in which its committee and agents worked under Colonel Loyd-Lindsay's guidance; no one doubted that whatever sums of money might be entrusted to it, would be laid out to the best advantage in the interests of the sick and wounded for whom they were intended; and so it was that funds and materials poured in from all sides, until they accumulated to the vast amounts which have been already described in Colonel Loyd-Lindsay's lecture.

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* See Colonel Loyd-Lindsay's Lecture on "Aid to the Sick and Wounded in "War," delivered 31st March, 1871, and printed in Vol. xv, No. 64, of the "Journal "of the Royal United Service Institution."

The question is occasionally raised, when the subject is reverted to in conversation, whether the benefits conferred by these vast gifts, repaid the outlay. I have no hesitation in saying that when all circumstances are taken into account, as they ought to be, the expenditure will be found to be quite justified by the amount of good effected. No one can study the subject thoroughly and impartially without coming to this conclusion. I myself, indeed, have been surprised at so much having been accomplished, considering the suddenness of the events which called the Society into existence; the absence of all preparation or previous organization to meet the wants suddenly created; considering the rapidity with which the successive phases of the war followed one another, each phase changing circumstances of place and requirements; and considering also, as I shall presently point out, that the Society's agents had no legal or authorised standing for interference at the seat of war: when all these things are taken into account, I think no other conclusion can be come to than that it is a subject for great congratulation that the Society was able to minister to the wants of the sick and wounded so materially, and to so vast an extent as it did.

I have endeavoured to make my conviction clearly apparent that the sick and wounded of both armies during the Franco-German war did derive material benefits from the English and other National Societies who interfered in their behalf, because I intend presently to ask the question whether, as a general principle, the plan of administering such international aid in time of war be deserving of encouragement or otherwise; whether there were not exceptional circumstances in regard to the late Franco-German war which prevented the harm resulting, which may be expected to result, if such international aid to contending armies be established as a system and applied to future wars.

Every one who reflects on the matter must become aware that the title of the British National Aid-Society was a misnomer, as were for the time being the titles of all the other National Aid-Societies who helped on the continent during the late war, with the exception of the German and French Societies. The funds were subscribed for international purposes; the work of the Society was international; and, to all intents and purposes, the Society was an International Aid-Society. Although thus thoroughly international and not national, it has been generally held and stated, not only that the Society was established under the warrant of the Articles of the Geneva Convention, but that the Articles of the Convention conferred on all those who were thus internationally engaged in aiding the sick and wounded, the privileges of neutrality and inviolability of person. It is this assertion on which I believe it to be important a right understanding should be come to; for that it is devoid of truth, the text of the Convention itself, as well as collateral evidence, will, I think, sufficiently show.

Is it true, however, that the articles of the Geneva Convention have been interpreted as I have mentioned? Is it true that the help afforded to the German and French sick and wounded soldiers by the English Aid-Society was supposed to be grounded upon, and to be facilitated by, the terms of the Geneva Convention? Quotation of a few of the published replies to one of the Society's questions will at once settle this point. Question No. 12, is:—"Would it have been possible to have come to the aid of the sick and wounded, as has been done in this war, without the facilities afforded by the Convention?" Here are some of the answers. "Not to the same extent, if at all."* "No."† "The Convention of Geneva has undoubtedly facilitated the aid afforded to sick and wounded in the late war; and this aid could not have been so effectually rendered without it."‡ "I am of opinion that it was owing to the facilities afforded by the Convention alone, that any effectual aid has been rendered by the National Society in the war."§ "Free locomotion in war time must always be difficult, and it would have been still more so had not the Articles of the Convention entitled all members of Red Cross Societies to circulate anywhere where their doing so did not interfere with military precautions or operations. The extent to which this was permitted may be inferred from the fact that newspaper correspondents frequently got attached to foreign ambulances so as to have the privilege of wearing their brassard, and penetrating where, as civilians, they would have been unable to reach."‖ "Most certainly not."¶ "Utterly impossible."**

These replies sufficiently prove that the officers and gentlemen who were acting under the directions of the British Aid-Society conceived that the Geneva Convention covered them with neutrality and protection, and that the Convention established a sort of right to administer help to the sick and wounded soldiers of the contending armies. Indeed, I need not rely upon the replies to the question which I have quoted, I may point to the whole series of replies to the questions put forth by the Society in proof of the universal prevalence of this belief among the respondents. One gentleman who was actively engaged in the work of the society informed me, on his return to England, that on one occasion, when he had been placed under temporary arrest by certain officers of the German Army besieging Metz, he had threatened to bring down upon them the interference of the British Government, his right to this interference being grounded on the Geneva International Convention of 1864. This is only one among many ways in which the mistaken supposition that the privilege of inviolability of person is conferred by the Geneva Convention on private gentlemen acting under the orders of an independent foreign society may lead to difficulties, but it serves to indicate how necessary it is that the nature of the Convention should be well understood, and its Articles rightly interpreted.

I formerly explained in this theatre the meaning attached to each article of the Convention by those whose business it had been to consider and define the terms of the Convention, but perhaps I did not enlarge enough on the limitations of the Convention in the particular direction I am now reviewing.†† Still I pointed to the fact that the

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* Captain H. Brackenbury, R.A.

† Seven Respondents give this reply.

‡ Colonel Cox, C.B.

§ Colonel Elphinstone.

‖ Mr. Austin Lee.

¶ Captain Norman.

** Dr. John Murray.

†† See Journal of the Institution, vol. x, page 162, *et seq.*—Ed.

Treaty only comprehended the military ambulances and hospitals of the belligerents, the staff employed in attending the sick and wounded contained in them, and the materials necessary for their proper treatment; that its Articles did not provide for any Volunteer or Independent Staff of Hospital Assistants; that such persons could only participate in the provisions of the Treaty by being regularly admitted into the hospital service and forming for the time being, part of the military establishments of the armies engaged, and thus becoming subject to the ordinary rules and articles of war. These latter would then come within the provisions of the Treaty, because then they would be comprised in the *personnel* of the military hospitals as laid down in the second Article of the Treaty.

To show how strictly the Treaty entered into by the different Governments of Europe confines itself to an acknowledgment of neutrality for the military hospitals of the belligerent armies, and to an engagement on the part of the belligerents to protect and respect them and their concerns only, I may point to the following circumstance. Prior to the Congress of 1864, in November 1863, an official circular was sent from Switzerland to the Governments of all civilized countries, making the following request:*—"Would the Government give its adhesion to an International Convention having for its objects: 1st. The neutralization in time of war of military ambulances and hospitals, of the *personnel* of the official medical service, of voluntary hospital assistants (*hospitaliers volontaires*) recruited by the Aid Committee, of inhabitants of the country who will go to help the wounded, and of the wounded soldiers themselves. 2nd. The adoption of a distinctive sign, &c."

This circular formed the basis of the deliberations which subsequently took place in the International Congress of Geneva, of August, 1864. After full consideration of the several subjects included in the circular which I have just quoted from, it was unanimously determined to exclude from the text of the Convention that part of the circular-note which suggested the neutralization of voluntary hospital assistants recruited by Aid Committees, and to confine the neutralization to the official sanitary *personnel* of the hospitals of the belligerents. This was done because it was plainly seen that the extension of the rights then proposed to be conferred by the Treaty,—not merely the right to be acknowledged neutral, and to be treated as neutral, but the right, also, to special privileges of respect and protection,—to volunteers not subject to military control, and perhaps not conversant with military arrangements, would very probably lead to incessant practical difficulties in field hospital administration which would interfere with the interests of the sick and wounded soldiers, and not improbably, also to disputes and embarrassments with foreigners belonging to countries with which the belligerents were on friendly terms. It was, moreover, known that several Governments would not give their adhesion to any treaty containing such a provision; indeed, I was myself informed by the representatives of more than one Government at the Congress, that they had orders to leave Geneva at once, in case the insertion of the neutralization of Volunteers in the proposed Convention, was insisted upon.

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* "Le Gouvernement adhérerait-il à une Convention Internationale ayant pour "objet: A. La neutralisation en temps de guerre des ambulances et des hôpitaux "militaires, du personnel du service sanitaire officiel, des hospitaliers volontaires "recrutés par le comité de secours, des habitants du pays qui iront secourir les "blessés, et des militaires blessés? B. L'adoption d'un uniforme ou d'un signe "distinctif identique pour les personnes attachées au service de santé, &c."

The Geneva Convention is simply a Treaty entered into by certain Governments with regard to the manner in which the sick and wounded of their armies, the staff employed in ministering to them, and the military hospitals and hospital *matériel*, are to be respectively dealt with in case of two or more of those Governments waging war with each other. All allusion to Volunteers, even of the countries engaged in war,—I need hardly say, therefore, all allusion to Volunteers from other countries,—has been rigidly excluded from the conditions of the Treaty. The Treaty nowhere contains any reference to the neutralization of any one not forming part of the Staff officially employed in the service of the ambulances and hospitals of the belligerents; there are no stipulations in it regarding private persons.

The mistaken ideas on these points have apparently originated in several ways. The articles of the Convention have been read apart from the preamble, which designates who the parties to the Convention are. Some of the Articles have been read separately, without reference to preceding Articles by which their terms and provisions are limited. The error has probably also been increased by the fact that at several meetings of delegates from the National Aid-Societies of various countries, especially at Paris in 1867, efforts have been publicly made to get the Governments who have adhered to the Geneva Convention to sanction the admission of independent volunteers, recruited by Aid-Societies, into that treaty, or to give them, by an additional convention, the same protection as was conferred on the hospital establishments o their respective armies by the original Convention. Had the Governments of Europe complied with these requests, the agents of the British and all other Aid-Societies would have had a legal status at the seat of war. But no such state treaty has been entered into, and, until this occurs, it is obvious, that the agents of Foreign Aid-Societies can only enter upon a theatre of warfare as private persons, with no claim to any exception to the restrictions which are usually imposed in time of war.*

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* Among the projected modifications of the Geneva Convention of 1864 which were discussed, and proposed for adoption, on the occasion of the International Congress at Paris in 1867, were the following:—

"The members of all national societies for succouring the wounded combatants "of land and sea forces, likewise their auxiliary *personnel* and their *matériel*, to be "declared neutral."

"The societies of succour shall put themselves in direct correspondence with the "head-quarters of Armies, or with the Commanders of naval forces, by the "medium of representatives."

"The societies of succour, on the consent of their representatives, at the general "head-quarters, or with the Commanders of naval forces, shall be empowered to "send delegates to follow armies or fleets on the theatre of warfare, and to second "the medical and administrative service in their functions."

Again, the fourth subject in the list of propositions put forth for discussion by

The assumption that it was by virtue of the Geneva Convention foreigners gave aid to the French and German sick and wounded soldiers during the war, was manifestly all the more groundless, because among those who were actively engaged in this work were citizens of the United States of America. One of the field hospitals administered under the English National Society, and one which had the opportunity of being of essential service from finding itself in a position where large numbers of French wounded happened to be gathered without almost any of their regular military medical staff, was composed partly of American and partly of English gentlemen, and was known as the "Anglo-American Ambulance." Some other hospital establishments during the war were wholly served by Americans. Now, the Government of the United States of America, although it has been specially appealed to several times on the subject, notably after the Berlin Congress of 1869, has always declined to join in or to accede to the Geneva Convention; nor has the United States' Government entered into any treaty with European Governments of a nature corresponding with the Geneva Convention. Manifestly, therefore, the American surgeons and nurses were not acting in France by virtue of any compact such as the Geneva Convention is.

In truth, Americans were acting, as all the other foreign volunteer hospital aids were acting, in great measure through the concurrence of fortuitous circumstances incidental to the great struggle which was in progress, the complete success on the one side and the utter break-down on the other, the rapid succession of events, the extent of territory over which the warlike operations were spread, the prolongation of the campaign during the winter season, and, as a result of these conditions, the immense demands for hospital necessaries, food, wine, clothing, instruments, medicines, surgical articles of all descriptions; so that the military authorities on both sides were prepared to welcome persons who did not come empty-handed, but, on the contrary, who came with almost unlimited resources and abundant stores ready to be given away on demand. They were there by sufferance of the contending armies, who were glad enough to receive the donations brought by them; not by any right conferred through the Geneva Convention.

The published replies to the questions put forth by the British Aid-Society contain many complaints on the manner in which the Articles of the Geneva Convention were executed during the war by the belligerents, and the question is discussed in them whether, in consequence

the International Committee of Geneva, and read at the first sitting of the second Geneva Diplomatic Congress of 1868, was the following:—

"4° Mettre le personnel des sociétés de secours au bénéfice de la neutralité."

These facts afford a sufficient proof of the interpretation put upon the Geneva Convention by the distinguished delegates of the National Aid-Societies who met in Paris in 1867, and by the International Committee of Geneva in 1868. The Diplomatic Congress that sat at Geneva in October, 1868, however, notwithstanding the application for the volunteer *personnel* of National Aid-Societies to be included in the provisions of the Geneva Convention of 1864, only extended its principles to maritime warfare; they left the text of the original Convention, regarding military operations by land, intact, and thus a second time fixed the principle of applying the privileges of neutrality to the hospitals and official *personnel* of the belligerents only.

of the particular matters complained of, it does not become necessary to alter the text of the Convention. I have examined these complaints carefully, and have found in nearly every instance that the complaint is based on the mistaken reading of the Convention which I have just been discussing. The complainants have presumed on themselves, or property in their charge, being entitled to special rights, to immunity from the usual results and incidents of a state of warfare, which no one had agreed to confer on them. As to the alleged violations of the Geneva Convention elsewhere published, many of them—not all, it must be admitted, but many of them—are traceable to the same cause, viz., a mistaken notion of the nature of the Convention itself.

The Geneva Convention was thoroughly studied in Germany a considerable time before the war of 1870 broke out. Instructions issued by the Ministry of War made all the Officers and soldiers of the Prussian Army and allied German States acquainted with its Articles. A complete code of regulations was prepared by the War Department for the guidance of the National Help Societies to Sick and Wounded, defining their organisation, administration, positions of action, and duties of all persons employed by them, with their relations to the regular Hospital Staff of the Army Medical Department and to all other military authorities in case of war occurring and the Armies of North Germany becoming mobilised. The National Help Societies were restricted from collecting or practising for future use any stretchers or other ambulance conveyances, any hospital appliances but such as were of the patterns authorised for the military hospital equipment, so that there might be no jarring or confusion in case of the national volunteer aid having to be incorporated with the official services to meet the exigencies of war. In short, all the necessary preparations were made by the Prussian Government in strict accordance with the spirit and text of the Geneva Convention, and, there is no reason for doubting, with full intention of carrying out its provisions in their letter and in their spirit.

On the other hand, the French Government had done scarcely anything of practical value in the matter since the time it had acceded to the Convention. The Articles of the Convention had not been made known to the Officers and men of the Army, and, as might be expected, they exhibited an amount of ignorance regarding the Treaty and its objects such as at the time provoked general comment. At first, indeed, not simply the soldiers in the ranks, but many of the Officers, including those of the Hospital Staff, were manifestly not aware even of its existence. No regulations had been prepared for incorporating the volunteer with the official Army medical service when the war commenced, and, as an inevitable consequence, all was uncertainty and bewilderment in this direction at starting.

Permit me to quote a short passage from an able essay on "Hospital Administration in Modern Armies," by a French writer, in a recent number of the "Revue des Deux Mondes,"* to confirm what I have just said. "Unhappily," he writes, "the Convention of Geneva was hardly known to the French Military Intendance, and at the opening of the war nothing was prepared to put it into execution. When we arrived at Metz, not a French Army surgeon, not a single infirmier wore the brassard, not one of the ambulance vehicles had on it the distinctive sign of neutrality." And the same writer shows that when the authorities of the French Intendance subsequently applied the Convention, either from carelessness or from not properly appreciating its terms, they issued their stamped brassards in profusion to persons not entitled to receive them. Thus the very authorities whose duty in France it was to see that the Articles of the Convention were strictly adhered to, neglected the Convention in the first instance, and contributed to its abuse in the second. No wonder that a marked change occurred after this time in the respect paid by the Germans to the French official brassards. No wonder also that a necessity is generally felt for a revision of the Convention of Geneva with a view to determine whether the limitations of its articles can be more strictly enforced, and whether, in the interests of the sick and wounded, it is possible to punish abuse of them by any other means than retaliation.*

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* Le Service de Santé dans les nouvelles Armées Européennes, observations et souvenirs de la dernière guerre, par M. Léon Le Fort, Chirurgien en Chef des Ambulances de Metz.—Revue des Deux Mondes. Tome xcvi, Nov. 1871, p. 124.

The remarks I have hitherto made have shown that the only Aid-Societies capable of being brought within the Geneva compact of 1864 are the National Aid-Societies of the countries at war with each other, and that in order that the *personnel* of these societies may have a legal title to the protection accorded by the treaty, that *personnel* must be placed under military regulations during the period of service, incor-

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* General Dufour, Honorary President of the Geneva International Committee of Aid to Wounded Soldiers, has circulated for consideration by the National Aid Committees, an essay recently read by M. Gustave Moynier, in which the creation of an International Court in time of war is proposed with a view to effect the repression of violations of the Convention of Geneva. M. Moynier, after showing the need which exists for such a judiciary institution, after indicating the various plans which have been previously proposed or employed for ensuring due observation of international laws and treaties, and referring to the constitution of the Committee of Arbitration agreed to by England and the United States with regard to the Alabama claims, reduces his scheme to the form of a projected Convention embracing ten Articles. The following extracts exhibit the principal points contained in them:—

Art. 1. In order to ensure the execution of the Convention of Geneva of the 22nd of August, 1864, there shall be constituted, in case of war between two or more of the Contracting Powers, an international tribunal to which all complaints of infractions of the said Convention shall be addressed.

Art. 2. This tribunal shall be formed in the following manner: As soon as war has been declared, the President of the Swiss Confederation shall designate by lot three of the Powers who are signataries of the Convention, excluding the belligerents. The Governments of these three Powers, as well as those of the belligerent States, shall be each asked to nominate an Arbiter, and the five Arbiters shall assemble without delay at the place provisionally indicated by the President of the Swiss Confederation.

Art. 3. The Arbiters shall determine for themselves their definitive place of session. The details of organization of the tribunal and course of procedure shall be left to them.

Art. 4. The tribunal shall only occupy itself with violations of the Convention respecting which complaints shall be made by the Governments concerned. The tribunal shall submit the alleged violations to a searching enquiry. The necessary facilities porated, indeed, for the time being with the staff of persons employed by the War Department of the Government concerned in the military hospitals, and must be occupied in one or other of the capacities particularized in the terms of the Convention itself. Only while so engaged, and on no other conditions, can such persons claim a right to participate in the benefits of neutrality, to use the language of the Convention. Persons belonging to the National Aid-Societies of non-belligerent countries, although the Governments of these countries may have acceded to the Convention, cannot through an *international* action, lay claim to any corresponding immunities or privileges under the Geneva Convention.

I will now glance at the question—is it desirable to establish systematically a plan of international aid, such as was afforded during the late war? Or that the provisions of the Geneva Convention should be extended to persons of neutral countries carrying international aid to the sick and wounded of armies at war with each other?

I have already acknowledged that a vast amount of benefit was conferred on the sick and wounded of the contending armies during the Franco-German War by the international aid which was afforded to them. It by no means follows this admission as a matter of course, however, that what was done during the late war can be done again with equal advantage in future wars, or, at any rate, that it would be judicious for a body to be permanently organised for affording such assistance. The question is a very serious one from whatever point of view it is looked at, and much may be said on both sides of it; but although cogent arguments may be urged on the score of common humanity, and our feelings strongly moved by appeals to this consideration, my present conviction is that such a system, if established, would be attended with a greater amount of evil than of good. That a nation should be always prepared for war, to defend itself if need be against insult or injustice none will gainsay; but it must be equally the wish of every right thinking person, that nothing shall be done which shall render the occurrence of war easy, or facilitate its continuance when once it has commenced. Now, although the existence of International Aid-Societies, if they were to be established and acknowledged by treaty as some contemplate, might have little *direct* influence in provoking or averting appeals to battle by states for the settlement of their differences, there can be little doubt but that an important *indirect* influence would be exerted by them. One of the greatest incumbrances of an army in the field is its sick, together with the wounded which remain after a general engagement; and the

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for instituting this examination shall be accorded by the signataries of the Convention, and especially by the belligerents.

Art. 5. The tribunal shall formulate its opinion in a verdict of guilty of violation, or not guilty for each case brought before it. If guilt be established, it shall pronounce a punishment conformably to an international penal law which shall be made the object of a Treaty forming a complement to the present Convention.

Art. 6. The tribunal shall notify its judicial decisions to the Governments concerned, and these Governments shall be held responsible for inflicting the sentences pronounced against those of their subjects who have been guilty of infractions of the Convention.

weight of this incumbrance has been vastly increased since so much public attention has been given to all that concerns the proper care and treatment of such disabled soldiers. If the sick and wounded are very numerous, the mobility of the army is for a time paralyzed, so long as the army has only to rely on its own resources for their surgical care and transport. But if a system of international aid be legally established and thoroughly systematised, these difficulties will in a great measure be removed. The sick and wounded will be given over to the care of international volunteer hospitals, and the mobility of the main part of the army will be restored. The Commander of the Forces will be at once ready to march onward, and, should occasion occur, to fight another battle. Thus the very object for which such societies would be established—that of mitigating suffering—would be defeated. There would be multiplication of wounded, and, in the end, unless the international aid were almost unlimited, less attention would be given to them. This is one important reason why the establishment of a system of international aid in time of war appears to me to be a thing not to be desired, even if it were generally practicable. Before the outbreak of the late war, no such system of international help had been established; and, therefore, the help which was afforded could exert no influence on the preparations made by the respective armies to meet the wants of their sick and wounded. All that was done by the British aid internationally given was so much in excess of what the sick and wounded would have had without such assistance; and hence the objects of the subscribers to the funds of the English Society were fully carried into effect. But if similar assistance is to be relied on in case of future wars of which this country might be a neutral spectator, who can say how far this reliance may influence the extent of the preparations made by the states entering upon the war for their hospital services? These are grave considerations which certainly ought to be well weighed in this country, where liberality, and the means of liberality, so much abound.

With these views regarding the doubtful expediency of systematizing international aid in time of war, I need hardly say it was a source of satisfaction to me that, although the work which called our English society into existence was really international work, one of the principles of its existence, and the first among them, was settled at the public meeting held at Willis's rooms on the 4th August, 1870, to be the contribution of aid to the sick and wounded forces of our own nation. This principle I hope will be mainly kept in view in the future. In this country especially, there appears to be a legitimate field for the operations of such a society. There are not in Great Britain the same facilities for making adequate provision to meet the requirement of the wounded in time of war as exist in other European States. In considering the best practicable arrangements for the proper care of the wounded in war time, the effects of the system of enlistment as compared with one of conscription force themselves on our attention, just as much as when the organization of the British Army at large has to be considered. Where an army is raised by conscription there is comparatively no difficulty in calling such numbers into the ranks that an adequate proportion may readily be withdrawn for training, and, on need arising, for acting in the special duties of bearers of sick and wounded, without material injury to the fighting strength. But when an army is composed of men collected by the costly process of enlistment, it is unreasonable to expect a like proposition to be available; at any rate, it is hardly likely to happen that the necessary numbers ever will be found to be spared from the combatant ranks for such training and duties. The combatants of an enlisted army must always be comparatively limited in number, and no avoidable diminution of that number is likely to be permitted. When active hostilities are in progress the concerns of the sick and wounded, from the very nature of war, will always be a secondary consideration. Now, however, that the regular army is strengthened not only by its Militia reserves, but also by a numerous Volunteer force, may not the latter be got to supply, under proper direction, at least for home service, a proportion of men willing to undertake those duties in aid of the sick and wounded, which in some continental armies are performed by a proportion taken from the companies of regiments? May not the collecting, training, and preparing Volunteers for the discharge of these duties form part of the work of the National Aid-Society? In case of a force consisting of Army, Militia, and Volunteers being brought together for defensive purposes in this country, it will be manifestly essential that the hospital arrangements for the sick and wounded, including the Ambulance Transport arrangements, shall be under the one supreme direction of the War Department; but it is impossible for this department of the Government to maintain in time of peace the number of Hospital Assistants and trained attendants who will be required in time of war, not only for meeting the first necessities of the wounded, and for conveying them from hospitals in front to others in rear, but also for giving that care and attention to them which become necessary for long periods subsequently. No Government has ever yet been able to do it, nor is it likely will ever incur the expense which would be involved in such a proceeding. But unless the persons who are to bear the wounded from fields of action, and who are to help in removing and attending to them afterwards, are properly trained and disciplined in time of peace, they are not likely to be of much use, are often likely to do much harm, when so employed in time of war. Few are aware how many lives and limbs in time of war, that might under other circumstances be saved, are destroyed by want of requisite knowledge for the discharge of these duties. A corps of trained bearers, composed of volunteers, whether organized into a distinct body available for service, wherever required, or collected, on occasion arising, from trained men out of the companies of Volunteer regiments, would constitute a body corresponding in its functions with those of the *personnel* of the Sanitary Detachments of German Armies, and might be turned to valuable account in many ways, while military operations were in progress.

I think we are justified in believing that the establishment of National Societies for Aid to the Sick and Wounded of Armies in time of War has obtained so deep and extended a hold in Europe, that no efforts made by persons who object to their existence will succeed in uprooting and putting an end to them. If this proposition be assented to, all must agree that the consistent and wise part will be so to direct their action, that no impediments to the military operations in which armies are engaged shall result from it, no risk of international difficulties be engendered; but, on the contrary, that their action shall be made to conduce, to the fullest practicable extent, to the mitigation of those sufferings to which the Societies owe their origin, and on account of the existence of which they are supported.

Regarding our own National Aid-Society from this point of view, considering its main purpose to be that of supplementing the regular hospital service of the War Department of the Government in case of the country becoming involved in war, the following appear to me to be principles which it is essential for the Society to adopt in order that its aid functions may be most efficiently discharged.

1. The National Society should direct its efforts in the first instance to procure official recognition, not merely as an independent body invested with special privileges, but as a Hospital Reserve for Help to the Sick and Wounded of our National Forces. It should seek to establish definite relations with the War Department through a representative Director of the Volunteer Aid Establishment.

2. The Society should devote itself to national interests. It should try to solve the important questions—in what direction, and by what means it can best supplement the official aid to sick and wounded in case of the country becoming involved in war, always keeping in view the special circumstances of the country, and of its Army organization. After these questions have been solved, it should take whatever steps may appear to be best suited for preparing itself in time of peace to meet the exigencies which it believes itself competent to meet in time of war.

3. A code of regulations should be prepared, and, when sanctioned, issued by authority, defining the duties and responsibilities of the Volunteer Hospital Staff, acting under the direction of the Society, in the same way as regulations are issued for the guidance of the combatants of the Volunteer Forces.

I have not attempted to discuss details, for it would be useless to do so before the principles of action I have named are approved and accepted. If these principles become established, the best method of filling up the outline sketched out, will necessarily form a subject of subsequent study. They are the principles on which alone, I believe, the Society can hope for its future operations to be attended with unmixed and reliable good results. If they be rejected, if the Society trusts to its own powers as a free and independent body, if its members confide in some presumed influence of the Red Cross without inquiring particularly into the statutes and limitations under which this sign has been accepted as an emblem by international treaty, I fear the Society will never be able to justify the name under which it exists; while, on the contrary, by adopting and acting upon them, I believe the Society may become an institution capable of affording essential assistance to our Government and country in the hour of need.

APPENDIX.

It may be useful to indicate, in some particulars, the manner in which the German War Department dealt with the Geneva Convention by official regulations prior to the outbreak of hostilities with France. A reference to some of the provisions of the Royal Warrant of the 29th of April, 1869, defining the "Plan of Mobilisation for the North German Army,"* together with a few extracts from the German Army Medical Field Regulations, will suffice for this purpose. First, with regard to the Royal Warrant above cited:—

1. This Royal Warrant contains, as an appendix, a reprint of the Articles of the Geneva Convention.

2. A section of this Warrant, headed "Instructions for the Army Medical Department in the Field,"† has been supplied by the War Office to all Officers commanding troops; and it is assumed that all combatant and medical Officers are thus acquainted with the instructions and with the Articles of the Geneva Convention. The troops also are made acquainted with them through the authorised courses of instruction given by Officers to the Serjeants and men at fixed intervals.

3. These Instructions contain the following passages:—

a. All persons belonging to the Army Medical Department must be provided, as soon as war commences, with the Neutrality-badge; Surgeons, Military and Civil Officers connected with hospitals, Hospital Orderlies and Bearers of Wounded being comprised in this category.

b. All ambulance conveyances, field hospital carts, waggons, and hospital tents, have to be marked with the neutrality sign.

4. The Directing Surgeon of each army corps, or, as representing him, the Surgeon in charge of a detached body of troops is required to designate beforehand the Surgeon, or Assistant-Surgeons, Orderlies, proportion of ambulance stores, and transport which, on events requiring it, such as wounded having to be left on the ground, &c., are permitted to take their risk of falling temporarily into the hands of the enemy under the protection of the Geneva Convention.

Further extracts from the Instructions for the Army Medical Department, before named, bearing on the subject of the Geneva Convention of 1864:—

Para. 2. The sick and wounded of allied troops, as also sick and wounded prisoners of war, are equally entitled to medical treatment.

Para. 7. During minor engagements the wounded will be taken to the temporary places for dressing wounds by the assistant sick bearers. As far as possible four men per company will be selected for this purpose from the men who have already been trained to this duty in time of peace. They will be distinguished by the white armlet with red cross worn on the left arm.

Para. 13. Temporary hospitals are to be denoted by the National Flag, and by a flag with red cross; after dark by a red lanthorn.

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* Mobilmachung's Plan für das Norddeutsche Bundesheer.

† Instruktion über das Sanitätswesen der Armee im Feldr.

Para. 19. In the event of a retreat, the Commander of the Sanitary Detachment must arrange that both men and *matériel* follow the Army. The Principal Medical Officer determines who of the surgeons and their assistants, with the necessary appliances, are to remain with the wounded under the protection of the Geneva Convention.*

Para. 24. The hospital buildings will be distinguished by the National Flag, and a white flag with a red cross.

Para. 25. In the event of a retreat, the Principal Surgeon of a field hospital is responsible that the transport as well as men and *matériel* not required, follow the Army, if possible, in conjunction with the nearest sanitary detachment. The personal assistance required by the sick who have to be left behind, will be determined by the Principal Medical Officer, and only follows the Army after assisting in the further treatment and care of the sick.

Para. 79. The armlets with red cross issued to persons belonging to the volunteer establishments, must bear the stamp of the Royal Commissioner, who is further required to furnish each person, to whom an armlet is issued, with a certificate of authorisation to wear the Badge of Neutrality.

List of persons taken from the Dress Regulations, who are to wear the *brassard*, or arm-badge, in time of war.†

During war the following are entitled, and respectively obliged, to wear the white armlet with red cross, the Badge of Neutrality of the Geneva Convention:—

1. Medical Officers in charge, and their assistants.
2. All persons belonging to Sanitary Detachments, Field Hospitals, and Hospital Reserve Depôts, as also the Hospital Reserves.
3. The Medical Officers, Hospital Assistants, Assistant Sick Bearers and train soldiers, with the regimental cars, and the train soldiers of the Medical Officers.

The armlets, which are to bear the mark of the regiments or corps in the middle of the joining, will be worn on the left sleeve of the coat or cloak in the middle of the upper arm.

Sir HARRY VERNEY, on moving a vote of thanks to Professor Longmore (which was seconded by Colonel Alcock), said: I feel sure that I speak the sentiments of all present by expressing our thanks and acknowledgments to Professor Longmore for the admirable paper which he has sent to us, and which Professor Maclean has just read. The interest taken in the subject of it by the whole nation was amply shown, not only by the very large contributions in money, and materials of all kinds, in the summer, autumn, and winter of 1870, but still more by the personal work of so many persons of both sexes and of all ranks, both at home, and when they proceeded to the seat of war, and aided in mitigating the sufferings of the battle field.

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* The Articles of the Geneva Convention are appended in extenso to this paragraph. (Beilage 4. Instruktion, &c., page 110.)

† Beilage 17. Nachweisung der Uniformen und Abzeichen des Sanitäts-Korps. (Instruktion, &c., page 159.)

But what has hitherto been wanting has been the intelligent direction what to do, and how to do it—how to utilise the efforts of zealous benevolent persons for the objects that we all had in view. That want is supplied by Professor Longmore's paper. He has given us in it the result of his thoughtful experience. He has pointed out how our efforts ought to be combined with, and, of course, in subservience to, the arrangements of the War Office and Government of the country, in case our armies should be called into the field. He has shown how we may be of use, without exciting the jealousy of our own or foreign authorities, and how we may act with that which, above all, is essential,—the goodwill and co-operation of our own military commanders.

There is no doubt that in the Franco-German war, the Red Cross was abused. He tells us how its abuse may be—indeed must be—avoided in future.

I believe that many of us are convinced, that only by regulations such as Professor Longmore suggests, and acting vigorously under them, will the "Aid-Society to Sick and Wounded in War" be able to carry out the objects for which it exists. We shall all study his warnings and admonitions, and they will be especially valuable to the Council of the Society, furnishing to them information and advice for the work which they have to undertake in directing the future operations of the Society.

We also thank Professor Maclean for his statement on the important duties of the trained Krankenträger, a statement founded, apparently, on his personal observation, and so pertinently illustrated by his reference to the case of that gallant American General, Stonewall Jackson, whose course we all, whether favourable to the North or South, followed with admiration, and whose untimely death we could not but deplore.*

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* On this point Professor Maclean observed, it is a great mistake to suppose that any men picked up in the street, or even taken from the ranks, are capable, without special training, of performing the duties of an Army Hospital Corps. On the contrary, it may with truth be described as a species of skilled labour. In the case of a man in the field, let us say with a simple fracture of a limb, if unskilfully handled by untrained men, the injury may in a moment be converted into a "compound" one, to the serious detriment of the sufferer, and in some cases fatal consequences may result. In this way the good and gallant Stonewall Jackson lost his life. He was wounded, but not mortally. The soldiers who removed him from the field did this in so unskilful a manner that death resulted.

Evening Meeting.

Monday, April 29th, 1872.

Lieutenant-General HENRY EYRE, in the Chair.

NAMES of MEMBERS who joined the Institution between the 16th and 29th April, 1872.

LIFE.

Campbell, H. F. J., Commander, R.N.
Craigie, R. W., Sub.-Lieut., R.N.
Lees, E. B., Major, 31st Lanc. Rifle Vols.

ANNUAL.

Jones, Lewis J. F., Lieut.-Col., late Dept. Batt.
MacDonnell, John R., Major, 19th Middx. Rifle Vols.
Stewart, Hon. Walter J., Lieut., 12th Royal Lancers.
Cochran, Francis, Capt., 37th Regt.
Philip, Francis L., Capt., 2nd Rl. N.B. Dragoons.
Tottenham, H. A., Major, Bengal Staff Corps.
Silver, Hugh A., Lt.-Col. 9th Essex Rifle Vols.
Gordon, W. C., Esq., Assist. Commissary.
Law, F. T. A., Capt., R.A.
Lees, T. Evans, Lt.-Col., 31st Lanc. Rifle Vols.
Westloe, F. H., Lieut., 2nd Rl. Cheshire Mil.
Gooddy, Edward C., Capt., 44th W. York Rifle Vols.
Higgins, F., Major, 6th Lanc. Rifle Vols.
Coyney, W. M., Capt., 3rd King's Own Stafford Rifle Militia.
Smyth, Geo. J. Fitzroy, Lt.-Col., Coldstream Guards.

THE AUTUMN MANŒUVRES OF ENGLAND.

By Captain C. B. Brackenbury, R.A.

If we study the rise and progress of all reforms or revivals in countries where public opinion has power, we shall find a general resemblance in their various histories.

There is, first, a condition of mind in the nation generally, rendering men ready to listen. Then there stand forth certain individuals who have read much or had much practical experience of the subject, and they speak their thoughts boldly as prophets, setting themselves at the same time like pioneers to clear away the obstacles which stand in the way of their favourite projects. At first their words have little power to lift the dead weight of custom. They are treated as dreamers and enthusiasts, and a thousand reasons are found for pronouncing their ideas absurd, unpractical, impossible. But by degrees the truth of their arguments becomes manifest to a gradually increasing group of hearers, and the possibility of their being right is felt more widely and deeply every day. It is at this stage that a new class of advocates appear, men who have wit enough to know that the change is coming, and love of novelty enough to be slightly in advance of the bulk of their fellows. The chorus grows louder, and overpowers the voices of the dissentients, who are soon found,—most of them at least,—declaring that, for their parts, they always saw the value of the thing, had indeed proposed it, but in some other form. All difficulties vanish, and the new belief becomes fashionable. But it is just at this point that the greatest vigilance is required, lest the fashion should become folly, and the life of the thing be pressed out of it under the weight of the applause lavishly heaped upon it. The men who first laughed at the proposal, then were wroth with the proposers, then said it was good enough, but unsuitable to the country and the epoch, then claimed to have been its originators; these men are still its enemies, for, finally, they go near to kill it with kindness.

It is, therefore, not surprising to find the mass of men oscillating violently from one extreme to the another, nor to see in the same community and at the same time, parties enunciating opposite dogmas as articles of faith, and quoting on either side the opinions of great men who never really differed.

Now it seems to me that there are just now in England two great principles which have got themselves generally accepted, but which men will persist in treating as antagonistic, though they are not so by any means. They are, first, the great laws of political economy, with their natural offspring, a love of peace and non-intervention abroad; secondly, the wisdom of readiness for war, with its corollary the necessity for practising during peace, the arts of war. So, on the one side we get men, otherwise sensible, who insist on the infinite wisdom of getting rich at all hazards as quickly as possible, and would clutch their money bags to their bosoms, terrified at every rough sound outside their house, rather than pay for a good watch dog, and a trained policeman: while, on the other side, we find Englishmen who see in the revival of the military art nothing less than a chance of interfering in all the quarrels of our neighbours; men who want to keep a pack of bloodhounds, and turn all their workmen into soldiers.

May it not be well that the moderate economists should declare themselves distinctly in favour of having and keeping up a good army fully able for all England's needs, and that soldiers who know what war is and what the chances are for an unarmed nation—alarmists, if you choose to call them so—should declare with equal distinctness that they want war no more than their friends on the other side, but that certain forces must be prepared for highly probable contingencies. It is also their business to say what those forces should be, and to what point they require training.

Speaking with all reverence of the now famous words of a wise and sober statesman, the present Lord Derby, I cannot agree that the problem as to the strength and training of the Army of Great Britain is quite so simple as he puts it. Let it be granted that we only wish to defend our own possessions, and not to enter into military competition with the great powers of the Continent. Still, every strategist will tell us that a passive defence is a weakness in itself, and that many parts of the empire could be defended with probability of success neither in England nor in the territory itself which would be in dispute.

Take, for instance, the case of India. I believe you will find that the men who are watching affairs in the East most keenly, because upon the issue of the Eastern question depends their national existence (I mean the statesmen and strategists of Austria), hold the opinion that we shall some day have to fight for our Indian Empire, not in Hindostan, but in the Valley of the Euphrates and on the plains of

Mesopotamia. I give no opinion on this subject, but use it merely as an illustration to show the complicated nature of the problem. Yet this problem must be worked out, or at least stated clearly, before we can tell what our Autumn Manœuvres should be. For, gentlemen, you will I hope agree with me that we have now reached a platform where we may stand for a moment, take off our hats to foreign armies, and say politely, " A thousand thanks for your kind advice, " assistance, and example so far; henceforth our roads do not lie quite " in the same direction."

It is impossible to devise schemes of military organisation and instruction, and get them adopted, or at least carried out to vital results, unless the peculiarities and prejudices of the men and women composing the nation be taken into account. Prussia adopted the system of general service, and made military strength the chief object of all her legislation. When? After she had been beaten and all but destroyed. Austria followed her example. When? After her awful lesson in 1866. France is now doing the same, or something very like it. If there is ever a successful invasion of England we shall not rest till we have created a system and an organisation, giving us military strength far beyond our requirements. At present, though we know not why, and certainly have no fear of military despotism, we are influenced by traditions of parliaments violently dissolved by Cromwell's soldiers, and again by soldiers after his death, of the atrocities committed by " Kirke's Lambs " in the time of James II., and of the mutiny of William's men at Ipswich, which brought about the passing of the first Mutiny Act.

So in proposing measures for forming and training a strong national army, it would be folly to forget that Englishmen are for ever thanking Heaven that they are not as foreigners are, and especially as those publicans the French and Germans. On the other hand it would be equally foolish to ignore the fact that we are a fierce and proud people, sprung from a race of warriors, and that, even of late years, the Government has had its hands full in taming, on certain occasions, the warlike spirit of the nation. Surely, then, we shall do well to be content with an army of moderate dimensions, while we should be culpable if we did not determine so to train that army with its reserves that, counting on the splendid and soldier-like spirit of the men, we may assure ourselves they are more than a match, man to man, for the troops of any other power. No doubt this feeling now exists in England, and, with its growth, has come also the acceptance of the principle that dull barrack-square drills are not preparation enough for war; that soldiers have something more to learn than how to face death and ignore defeat; that the science of war has been developed of late years to an extraordinary extent; and that we must not put off the study of it till the day of trial. The nation created its army, and all the world admired its perfect appearance and passive discipline. The nation began lately to love its army, and only then discovered that, like the offspring of Pygmalion's genius, it was cold and pulseless; I say it *was* pulseless, for it is so no longer. The spirit of progress animates it, and in response to the demand of the country the life-blood of intelligence is coursing through its veins.

Our military schools are improved and active. Our drills are now considered as means, and not as an end in themselves. Over all the country we read of small bodies set in array against each other, instead of opposite a brick wall, and we have already had our "Autumn Manœuvres," which were so successful that they have become as much an institution of England as Parliament itself. There was not a little about them seeming to challenge criticism, but that criticism has been so freely expressed, and taken in so good a spirit, that we may safely refrain from remarks on the past, and rather turn our attention to the future. It has been the will of the Council of this Institution that I should play the jackal to the lions' feast, and point out some game for those who are much wiser and stronger than myself to hunt down. It seems, therefore, better to employ a few minutes in speaking of what may be, rather than of what has been. So many things may come to pass if we will only let them. There are special English difficulties, it is true, but also special English facilities, and is it not a little weak to harp for ever on the former, and never try to get one strong tone out of the latter?

It is said that England is so highly cultivated and so rich that it is hard to find waste lands for large autumn manœuvres. Cannot, then, this rich and mighty country afford to pay for the training of its protectors, even if land not so very waste be selected? Just think for one moment of the absurdity of grumbling about the expense of such manœuvres. Why, the results of an income tax of one penny in the pound for one year, if invested, would pay for the autumn training of the English Army for ever and ever, including compensation to farmers.

It is said, "Rich men don't like to have their shooting disturbed, "and farmers and labourers are so independent." This is frequently asserted; but is it not fair to reply that the English gentleman holds his title to the name on an implied, if not an expressed, tenure of ready service to his country and high example to his tenantry? Was it only in the breasts of poor sailors that a fruitful soil was found for Nelson's signal, "England expects *every* man to do his duty?"

We are going to educate all our workmen and labourers, to open their eyes to their own power, and to increase that power by knowledge. Is it not rather a serious question whether country gentlemen mean to set them an example of self-denial and patriotism, or of dogged and stupid selfishness?

Hodge is capable enough of cultivating certain sentiments. When we get him in the Army he soon acquires *esprit de corps.* Cannot the country gentleman teach him, especially by example, the idea of duty owing to his country? If not, it seems to me that there is a bad prospect for country gentlemen when Hodge becomes sharp enough to be dangerous.

But we may take it for granted that the country gentlemen will be wise and duty-loving, and that we shall have autumn manœuvres regularly.

The next question is, How best to turn them to account?

The first point to which I crave your attention is the necessity for systematic preparation before the autumn manœuvres, in order that no time may be lost when the camp is formed. Every regiment, every Officer, and every man should go to the manœuvres knowing, each one in his own sphere, how to perform whatever may be required of him. Let it be granted, for instance, that all men in an infantry regiment know how to march well, to perform all the parade movements with perfect regularity, to skirmish according to the drill book, and to perform ordinary outpost duties. They are just ready to begin their real instruction for war, or their preparation for autumn manœuvres. Let us set down a few of the subjects to be studied at this stage by companies and battalions, not waiting for formation into brigades and divisions, for it is then too late to learn minor details. Only first hear some passages written by an Officer in the Prussian Army about the French just before the war of 1870. They are very striking and instructive if we read them aright. Baron von Ludinghausen, after finding fault with the French for not giving Captains of companies enough liberty of action in training their own men, proceeds, " The superior Officers, like the Captains, in France have not nearly " the liberty of action and the initiative which are permitted amongst " us." On this point the Baron harps again and again—the stupidity engendered by over centralisation instead of giving each Officer his own responsibility. He adds, " The exercises of field service, having " for their object the fight on rough ground and around positions, and " special localities, the service of outposts, service on the march, finally " certain minor operations of war (ambuscades, surprises, escorts or " attacks of convoys), &c., are much more rarely practised in France " than among ourselves. Further, they are much less instructive, " since they are never made with two detachments operating one " against another, hardly even against a pretended enemy. Besides " (I pray you to mark this) "the French fancy that because of their " natural military aptitude such exercises are only necessary in a " minimum proportion, being convinced that the want of practice will " not hinder them from doing wonders in the field."

Now for a few of the practical details to be worked out by small bodies of men before they are fit to be brigaded together with hope of really useful instruction.

First.—Place them on ground such as men fight over, not a beautifully levelled parade, and teach them how to act on the defensive. Show them the advantage of being themselves concealed, while they have in front of them a free space over which the enemy must advance—how to combine the action of dispersed troops with that of troops in ranks—the necessity of studying the ground in front of them—how they might be supported by other infantry, by guns, and by cavalry. Practise this for some time carefully.

Second.—Show them how an enemy placed as they themselves were should be attacked, both on open and on close country.

Third.—Choose a position as strong by nature as can be found, strengthen it further by art, and show them how the force should be distributed most economically, how the flanks should be protected, and the best position for the reserve.

Fourth.—Attack the same position, supposing either that the force employed is alone or is only the advance guard of a stronger body.

Fifth.—How to fight in retreat on different kinds of ground, either when relinquishing a position or foiled in the attack upon one—action as a rear guard—positions of refuge—how skirmishers can cover a retreat, and what kind of fire is best to be employed—how and when to retake the offensive. Show them the necessity for covering the line of retreat.

Sixth.—Practice receiving cavalry, when skirmishing in line, or in column—choice of position to receive strong bodies of cavalry.

Seventh.—Attack and defence of woods, pointing out the advantage of holding the outskirts and roads with great vigour; how the interior should be held and communications so maintained that isolated detachments may not be cut off; difference between mere covers and forests; how to march through a forest where the enemy may be; difference between the action of an isolated body and an advance guard crossing wooded territory.

Eighth.—Defence and attack of defiles, holding the front of the defile, the rear of it, or the interior; attacking an enemy posted in these several positions.

Ninth.—Fights in inhabited places, such as farms, villages, and unfortified towns; placing buildings in a state of defence; breaking up or holding vigorously the entrances and issues; the struggle within houses; street fighting; how a small force of trained soldiers can defend themselves against insurrection from the inhabitants of an occupied town.

Tenth.—Field works—how to make them, defend them, retreat from them; when and how to occupy the ground in front. How to place the reserves. Building and defence of block-houses. Attack of field-works—how to reconnoitre them; to envelop them with skirmishers or swarms; to use groups of workmen for demolishing them; the rare occasions on which they can be attacked in column or in line.

This is a formidable, though still incomplete, list of minor operations which may fairly be taught to every regiment in the service, and ought to be taught to it before pretending to undertake either autumn manœuvres or war. It is not original, and some of you may know whence I obtained it.*

All these things having been thoroughly explained to bodies of infantry acting by themselves, it remains to practise them in small and handy numbers working against each other, in combination with different proportions of cavalry and artillery, and you may then add to them the crossing of streams and of rivers, with the defence of the same.

Now, is there anything in all this which Officers and soldiers may not fairly be expected to have at their fingers' ends? We may go further and ask, is not all this fifty times more interesting and more likely to develop a true military spirit, together with the soundest discipline, than all the marchings and counter-marchings on level ground that ever were heard of? Can anything be conceived more likely to make the troops cheerful and to develop that feeling of self-respect, without which no man is more than half a soldier? The terrible mistake we too often make in England is to suppose that only Staff Officers need know all these things. In the famous *brochure*, "The Battle of Dorking," the author has shown a marvellous instinct (if indeed it be true that he never saw the Prussians fight) in representing the English Volunteers as defending their position bravely, though without understanding, till suddenly they found the enemy leaping down among them where they were not expected. Pray do not believe those careless people who represent the Prussian mode of fighting to be invariably in heavy columns. That plan was tried by them at the beginning of the war, just as smooth-bored field guns were tried in 1866. All the results told against the smooth-bores and the heavy columns. The former were withdrawn from the field at Koniggrätz, the latter dissolved themselves into swarms. There is now not a smooth-bore field piece in the Prussian Army, and the attack by swarms of skirmishers is now the rule—not the exception. Swarms enveloping any stiff formation opposed to them, whether column or line, stinging it into mad terror and breaking of ranks, while the swarms are drawn together in groups for a rush against any weak point, if an Officer do but call them round him by well-known signal.

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* Such lists are to be found in the index to many a foreign book on war. This one happened to present itself, just when wanted, in that most excellent and useful French journal, the "Revue Militaire de l'Etranger," which is a cheap and very valuable summary of military doings throughout Europe. It appears every fifth day. I get my copy through Mitchell.

Such opportunities are sure to occur, and to pass as quickly if the leaders of small bodies are afraid to take responsibility on themselves and must wait for orders from a General before acting. But to avail themselves of opportunities they must have full confidence in their own resources. They must be able to read a battle as a book, and how can they read without having been taught beforehand?

Here we find ourselves in presence of a question which I confess to approach with great misgiving as to the reception of what must in all truth and honesty be said. I hold that the grand British line, with its steadiness, its stolidity, and its noble traditions, is no longer applicable to modern warfare, or at least can only be regarded as quite subordinate to the attack by swarms of skirmishers well supported. Neither line nor column can advance across the open in the face of breech-loaders and mitrailleuses, and no formation is less able to take advantage of broken ground than a trim, well-ranged line. It must break its ranks, and then it is the *British* line no longer.

Wellington claimed for line over column certain advantages when the line was composed of steady Englishmen. Exactly the same advantages under the new conditions of warfare, has the well-trained and steady swarm of skirmishers, now distributed, now in groups for attack, over the formation in line. Pray do not reject this opinion as the insolent dogma of a lover of change. If Wellington were here now he would see in it but the legitimate development of his own principles and his own faith in the steadiness of the British soldier. So surely as men go into action in line so surely will they have to break their ranks or remain useless. Is it not better to let such breaking up of formation take place according to a well-known and carefully arranged plan, so that there may be no loss of confidence, and the soldiers may feel "This is nothing unexpected; we have been trained to it, and know what to do?" What the line is to the column that is the looser formation to the line, requiring even steadier and better taught troops. The old arguments of Wellington might be used almost without alteration in favour of the proposed development of his principles.

The reasons why the change is called for are two-sided, but come directly from the improved range and rapidity of fire possessed by modern weapons. In the first place, no line advancing with the steady pace at which alone a line can advance could possibly remain unbroken if the enemy be but moderately steady; and in the second place, skirmishers or swarms are as safe against cavalry as ever a line was, and can deliver an even more deadly fire than a line could with the same weapons. Therefore both safety and economy of men are concerned in favour of the change. The question should be settled soon, because the training of the soldier in shooting is seriously affected by it. There is a controversy now proceeding in Germany whether the bayonet, always fixed as it is now, should be retained, or a sword-bayonet—to be worn by the man's side and only fixed in emergencies—should be substituted. In the course of the dispute there has been unmistakably shown the opinion, now almost universal, that trained infantry can fight as steadily and do as much execution in extended order as they could formerly in column or line. Let us hope that no veneration for existing systems may prevent the speedy settlement of this question, which is, I believe, the most important one of the day.

The next subject I would lay before you for consideration is, How to get the best possible information of the enemy's doings. Spies are all very well in their way, but they cannot come in from hour to hour and tell you what dispositions the enemy is making, especially in the midst of a battle. Here again we are particularly fortunate in the character of our troops. Just as the English infantry soldier may be trusted, before all others, to act boldly without feeling the touch of comrades on either side, so the English cavalry, with their splendid courage and good riding, may be trusted to dash into the very midst of an enemy and bring back information. I propose that, besides their regular outpost and patrol duties—besides their skirmishing—they be used, during the fight itself, in small parties of half-a-dozen or so to make raids, wild rides in fact, for no other purpose than to get information. I can vouch for the fact from personal experience, that English cavalry can catch this idea, and, with a little practice, act admirably in the manner proposed. They must make a bold rush in a certain direction, break up like a shell in the presence of the enemy, and get back—some of them at least—with intelligence. They are sure not to be all killed or caught, and a Victoria Cross would be well earned in war by clever daring in such achievements. Grumblers are apt to say that modern arms are driving all the chivalry out of war. Never was there a falser supposition, and never was there a time when cavalry were of more value than now, if only they are used freely and for proper purposes. Cavalry can learn such work best during the year by the manœuvres of small bodies against each other, and show their mettle in the autumn. But to try them thoroughly it is necessary that our mimic war should not cease with the Umpire's decision each day of the manœuvres. One of the chief advantages possessed by the Prussians over the French in the late war was their admirable use of cavalry to conceal their own movements and to discover those of the enemy at all times—not only during actual engagements. What is there to hinder cavalry from performing a little night work during the summer months? The chief objection appears to be the damage likely to result to the men's uniforms. This leads to another proposal I venture to make, namely, That a dark-coloured blouse, somewhat similar to a Norfolk jacket, with pockets, be adopted as the costume for all troops during manœuvres, and that the men be forgiven if the jackets are not always so trim and unstained as their tunics. We are to be a hard-working Army, and we need not be ashamed if, on special occasions, men and Officers bear about them some of the marks of work. Already the late manœuvres have settled the adoption of the long boot for mounted men. It is only to go one step further and decide on a regular fighting costume for campaigns as well as manœuvres. The patrol jacket is not quite the thing, though I can vouch for its comfort, having worn it, both during a summer and a winter campaign. One more word on equipment for your discussion, if it so please you. Cannot we now get settled for evermore what is the least amount of kit that soldiers want in the field for a few days, or even weeks? The advantage of light equipment can hardly be over-estimated. With Norfolk jacket, cloak, a pair of shoes, and a well-filled haversack, I see no necessity for carrying knapsacks and valises. They might be left always some marches behind an army, being certainly less needful than the third reserve of ammunition.

So far we have spoken chiefly of infantry and cavalry separately. Their action can be easily observed, and the Umpire's decisions regarding them are not difficult. The use of artillery during the manœuvres is not so simple. It is easy to say that they should do exactly what they would in war, but the difficulty is, how are they to make the presence of their fire known? We may take it as pretty well established, that guns should not go closer to the enemy than 800 or 900 yards as a rule, and that an extra 400 or 500 yards' range anywhere between 900 and 2,000 yards, is of little account compared with the occupation of a favourable position. But it happened frequently during the manœuvres of last year, that guns were in action against an enemy who entirely ignored them. I see no remedy for this but attaching an assistant Umpire to each battery, who should call the attention of the enemy to the fire which is being poured upon him. The message would not be as rapidly conveyed as that borne on the wings of a projectile, but it would at least be of some value, and add to the usefulness of the manœuvres.

You will recollect that last autumn an order was issued by the Commander-in-Chief freeing the action of the guns, and thereby enabling them to make their full power available; but there seem to have been some exaggerated ideas on the subject, and, being an artilleryman myself, I cannot be accused of retrograde opinions if I endeavour to show that the freedom of artillery may be overdone. It would be madness to suffer Officers commanding batteries to wander about the field taking up positions and firing at such portions of the enemy's forces as seems good to them without reference to the Commanders of divisions. The wisest course seems to be this: The General of division should communicate either through the artillery Colonel on his Staff or directly to Officers commanding batteries what he intends to do, and either order them simply to support him, when the whole responsibility would be theirs, or to concentrate their fire on a certain object, when, for the moment, their only responsibilities would be the selection of positions, the choice of projectiles, and the rate of fire. As a rule, the latter would appear to be the best course, for, while it is an axiom that the fire of artillery should be concentrated on the most important point, no one knows at the moment so well as the General what he considers that most important point to be. On the other hand, the artillery Officers know by personal observation and acquaintance with the powers of their arm how best to give effect to the General's wishes, and they ought to have the right and responsibility of acting for themselves in emergencies, even to the extent of directing their fire on a new object. Again, field batteries should certainly not go into action and crawl about with a whole line of ammunition waggons close to them, and as much exposed to fire as the guns. Field batteries cannot work with the speed of horse artillery, but they may at least avoid the opposite extreme.

While treating of artillery alone in its place at manœuvres, I cannot but ask, "Where are the mitrailleurs and the range-finders?" Of the latter it may be said that their value has been proved abundantly, that they save ammunition from being wasted, and increase largely the effect of artillery fire by adding to its certainty. No one who has stood under French shrapnel fire, and seen shell after shell burst innocuously far over head, seen also the Germans laughing at them and rising every moment in confidence as to their own superiority, could have one doubt on the subject. And we know that, as to mitrailleurs, the French have seen no reason to doubt their value; the Austrians and Russians have got them. The Prussians alone, so far, deny their value in the field, though they admit it for sieges. But the Prussians never admit the value of anything that costs money until they possess it; and I can vouch for the fact, that the soldiers held the French mitrailleuses —unwisely used though they were—in more dread than the French artillery. Let us try a battery or two of them in the field at the manœuvres and we shall soon see the use of them.

Of the supply departments and transport, it is to be remarked that until lately we had no organization (properly so called) of the kind. The departments are new, and all we can say of their action last year is, that they were totally inexperienced, and that they neither performed wonders nor broke down. This year they will be watched carefully and critically. It seems to me that we ought not to rest satisfied with them till they can feed an army on the march; and we have surely advanced far enough in organization to supply each division from its own base, not all from one common centre. Then there would be no necessity for fixing absolutely day by day beforehand where the camp is to be without reference to success or failure. In this case again, it is vain to quote English difficulties without quoting also English facilities. Perhaps the Supply Departments may win their spurs this time. We shall see. It seems to me that their work all the year round ought to be assimilated more to the supply of troops in the field, and I believe that both efficiency and economy would be promoted thereby.

Hitherto we have spoken of the three arms in their separate action. It remains to say a few words of their combination and action together. Presuming that, this time, the troops will be organised into brigades and divisions, with definite proportions of infantry, cavalry, and artillery, and a definite number of guns told off as reserve, and that the supply departments will be able to ensure these divisions freedom in action; furthermore, that all the subordinate Officers and the staff know their work thoroughly; then why not divide the forces equally, and leave them free for some days (except so far as they are bound by the umpire's decisions) or until one side or other is distinctly defeated? One side must win in every game, and it is a special characteristic of Englishmen that they know how to take a defeat with equanimity. Surely there would be more satisfaction in fighting a mimic battle to the end, and then the General who is worsted showing that he knows how to retreat steadily, than in leaving the decision open for everlasting controversy.

Besides, how else are the troops to practise pursuits and retreats, unless, indeed, one force be ordered to consider itself beaten at the beginning of a day, and to retire before a pursuing enemy? Many a General has lost a battle, but restored the fortunes of the campaign by his good dispositions afterwards. Again, the use of cavalry is specially shown in checking a pursuer or in pursuing. No one can complain that last year the battles were for the most part but a series of field days on a large scale. Everybody was new to the work. This year something higher might be tried, even though the manœuvres are confined to the plains of Salisbury, and the "streak of silver sea" treated as though it did not exist.

We all need special practice of outpost duty: dull work when there is no enemy to watch, as alone the French have practised it according to the quotation I read at the beginning of the lecture; intensely interesting if an enemy be in front, even though he be but a friend in disguise. The excitement of deer-stalking is not the final shot, but the approach—when man's brains are pitted against animal instinct, and cool calculation against senses sharpened by life on the heather or in the forest. So it may be at the manœuvres;—the whole game so intensely interesting, that the players forget themselves in the sport, and are content though the first days of September are slipping by, and not a partridge yet slain by their hands. This cannot be done so long as an hour is named for the commencement of operations each morning, and a particular spot told off for encampment in the evening. It was wise to place these restrictions on the troops last year, for the whole affair was new to most of those concerned. This time we may safely take a further step. I plead for only one at present, namely, to let the manœuvres be fairly worked out by those concerned without interference, until interference becomes necessary for special reasons. If such freedom be given, each army will have to protect itself by a complete system of outposts at night as well as by day. There will be scope for carefully considered tactical combinations, for flanking movements, for construction of field works, for pursuits and retreats ; even, I hope, for attack and defence of convoys. The supply departments will be fully tested, and all who are engaged will learn a great deal. They will have to take a great deal of trouble, but how can we hope for success in war if we do not take trouble to prepare it in peace. If we were never going to have war again, I should say, why keep an army at all? But the day for that foolish notion is past. We know that we are never safe from the chance of war. How reckless should we be then—we soldiers, and how unfit to be trusted with the honour of our country, if we were to allow considerations of personal comfort to stand between us and the knowledge which is undoubtedly necessary for success in war. I am often met, when advocating such manœuvres as these I now propose, by the reply, "You don't consider how the men's "clothes will be stained by anything like bivouac work." I might answer, "Has then a tailor-demon taken possession of the British Army, "and is it prepared deliberately to sacrifice efficiency to coats and "breeches?" But I believe that no such spirit possesses the Army generally, and that the men would give a sigh of relief, and stretch their liberated limbs with delight if they were given a comfortable dress, and told that they were not to put on their tunics again till the final parade after the manœuvres.

Only the other day, when we had a little manœuvre at Ipswich, and my men had to march out through a drizzle in order to be at Woodbridge by half-past eight in the morning, I gave them choice of cloaking or not. Through their non-commissioned Officers, they all expressed their wish to remain as they were. Again in the afternoon, when the manœuvres were over, and our tents were pitched, there came down a tremendous shower, hail and rain. I saw many of the men standing out in it, many more than were necessary for care of the horses. I asked them, "Why don't you get into the tents?" The answer with a cheery smile was, "We don't mind the rain, Sir. Let the civilians "get under the tents." Now I maintain that this is the real feeling of the typical British soldier, and that it takes more trouble to put the tailor spirit into him than it would do to teach him everything that soldiers ought to know and do. Therefore I believe he would hail with satisfaction a little additional roughness of life during the manœuvres, provided always he saw the sense of it, and was not called upon to pay for extra clothes. That would be a little hard on the married men.

All, then, I pray for as to the combined action of the three arms is, that more liberty be given this time. Then everything will come right by degrees, as it would during a campaign if only the enemy gave time for practice and re-arrangement.

With regard to the Umpire Staff, Officers present at the manœuvres last year seemed pretty unanimous in the opinion that the umpires should be distinctly attached to particular portions of the force, so that no important event could happen without the presence of some one to give a decision upon it. Again, each umpire requires well mounted assistants or deputies to bring him intelligence, carry messages, or decide minor points in the absence of his chief. These assistants might remain always present with the brigade to which they are attached. Then, whether an operation were performed by day or night, far or near, there would be some responsible neutral on the spot to give an account of it.

Recapitulation.

Let us now recapitulate the subjects I have brought before you so far, still supposing that we have only ordinary land manœuvres like any other nation.

1st. It is absurd to devote ourselves to getting rich without taking care to protect our riches. The richer we get the more protection we need. Without desiring war we must be always prepared for it.

Autumn manœuvres are one of the most necessary steps in preparation, and the cost of them is as nothing compared with their usefulness.

2nd. It is a simple duty for country gentlemen, from whose families, by-the-by, most of our Officers come, to help such manœuvres, even at the cost occasionally of a few partridges.

3rd. The manœuvres will not have half their proper usefulness unless preparation be made for them during the year. In short, the whole system of drills needs revision. Every regiment or battalion, and every battery, ought to be instructed in the minor operations of war. Garrison field days should have the same object, and that abomination, called in popular language the "Sham Fight," where all is sham and nothing is less like fighting, be abolished as a pestilent nuisance. All drills should suppose the presence of an enemy, and all instruction to the men be given distinctly with a view to war, not how to get into Hyde Park and out again.

4th. In war much often hangs on the decision and knowledge of junior Officers. Hence the more responsibility can be carried down to the inferior ranks, and the less it is centralised, the better for the service, therefore the better for the country.

5th. However painful it may be, we must meet the fact that open advances in line, and open resistance by men standing boldly upright in line, is now as impossible to the English as to any other nation. On the other hand, no other troops are so gifted by nature as the English with qualities which will insure success in the new fashion of combat—swarm formation,* and with the new weapons, breechloading, long-ranging rifles, and rifled field guns. Therefore, we should cultivate the new method with the utmost assiduity, and practise it at the manœuvres.

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* Inkermann seems to have been fought by our troops in loose order, though they were untrained to it. Because the men who captured the Redan were untrained to such fighting, they knew not what to do when all formation was, of necessity, destroyed.

6th. No time should be lost, no trouble spared in working cavalry, so as to get the best information. We want an "Intelligence Department" in the British service. When it is established, some of its Officers should attend all the manœuvres, and be responsible that the Generals are well informed. No Officer requires more careful training than the Cavalry Officer. Outpost duties should be practised everywhere during the summer.

7th. The tailor-demon must be driven out wherever he has got a footing. A special fighting jacket, with pockets, should be issued to the troops, to be worn at all practical manœuvres during the year. Advantage should be taken of the autumn manœuvres to discover and lay down the lightest possible equipment for the British Army. This is a great subject in itself.

8th. Messengers of some sort are required at the manœuvres to claim effect for artillery fire. Mitrailleurs and range-finders are imperatively demanded by modern requirements. We have the only good mitrailleur—the only range-finder at all; both of them should be issued and tried at the manœuvres.

9th. The supply departments should be used this year just as they would be in actual war. If they have the disadvantage of being hampered by English customs, they have, on the other hand, English roads and railways. The two opposite forces at the manœuvres should be separately organized, and separately supplied.

10th. The opposing armies should be left as free as possible, and for as long as may be without confusion. The Generals should get their own intelligence, and form their own plans. Pursuits and retreats should be practised. Outpost duty should be insisted upon with the utmost rigour, encamping grounds being marked on the map. Generals should have freedom to encamp on any one of them at pleasure.

11th. Umpires, furnished with assistants, should be attached to particular portions of the forces. If the umpires are required at head quarters the assistants should remain with the camps.

12th. The principle of having a chief of the Staff to each division should be adopted at once, applied to districts or large garrisons, and carried into full effect at the Autumn Manœuvres.

I have reserved to the last, though I am far from thinking it is the least important, a subject to which I now ask your attention.

We Englishmen have been content up to this point of our history to follow for the most part continental ideas about war. This has been natural enough, for most wars, and, therefore, most experience of war, were to be found on the continent. Yet we have always had a natural aptitude for war. In the middle ages we imported the manufacture of gunpowder and the art of war from Italy. In the reign of Henry VII we imported the manufacture of iron ordnance from the low countries. Yet what name was more famous in Italian wars than that of Hawkwood? What guns are now more famous everywhere than the English? What experiments are quoted except ours?

Now we have imported "autumn manœuvres," it will be hard if we don't make all nations come here to learn from us. At the beginning of this lecture I said that we ought to strike out a line of our own. For your discussion I propose what I think that line ought to be. We have lately heard little of any subject except army reorganisation, but we must not forget that we are a maritime nation. Not a mouse can creep out, not a giant can enter without being forced to undergo the trouble of embarkation and disembarkation, and frequently to suffer the pangs of sea-sickness. The sea is our first line of defence, it is also a barrier which might in certain cases shut us in when we would fain go out. It seems, therefore, our manifest duty, as it is certainly dictated by common sense, to work out thoroughly the subject of embarking and disembarking troops, of coast attack and coast defence. Furthermore, we are a country of railways, and in every scheme of defence our railways must play a prominent part; yet, strange as it may seem, though other armies have regular "railway drill," we have none. Though other nations have in their war offices perfect schemes drawn up for conveyance of troops on different occasions, we are content to leave all such calculations to civilians, and never test them at all, for the volunteer reviews are no test, the railway work being simply the conveyance of infantry alone, without baggage or stores. When the troops were first going to the East in the early part of the war which we call the Crimean war, I used sometimes to go down to the dockyard at Woolwich to watch them embarking, and I can assure you that they often made a precious mess of it, so that at last it came to be a sort of bundling them on board by men from Woolwich, who had the whole business by that time at their fingers' ends. Now we really ought to beat foreigners at railway and ship work, and we might have a good deal of it during the year. For the present our "autumn manœuvres" on their usual scale and system may suffice. In the future we may fairly look for a trial such as I will now attempt to sketch out—always for your discussion.

First, we must make what we have not at present, but foreign nations have, places on all our railways for the embarkation in trains of many troops at once. All that is wanted is an inclined plane *outside* the station, covered with earth so that it may seem natural to horses, rising to the exact height of the railway trucks, and extending to the length of a long train.

Next, we want large, strong, flat bottomed boats for embarkation and disembarkation.

Then, for our special English manœuvre, which all the world would flock to see, let us embark 10,000 men, and send them off under charge of an experienced Admiral, who should have no orders but to choose his own place and disembark them there as quickly and as scientifically as he could, protecting the landing with the guns of the fleet. Nobody in England should be told where he means to land, and we should then learn something about the difficulty of evading an enemy's fleet and landing troops on a hostile shore. Further, we shall know what is the difficulty of watching an enemy's fleet, and of sending troops, horse, foot, and guns, to oppose a landing. For my part I believe, though I am open to conviction, that, provided the attacking transports can be covered, or can evade the defenders at sea, the landing on a coast is one of the simplest operations in war. I may be wrong, but at least let us not live in a fool's paradise for want of a little experiment. If the attacking forces avoid harbours, and the ends of railways, and attempt a landing at several places at once, I really do not know how they are to be hindered. Why not try? Experiments of this kind are certainly not fruitless. Every such trial is a new interest to both Army and Navy, teaches a thousand arts, opens many closed eyes, shows how every soldier or sailor, whatever be his rank, must accept his share of responsibility, and adds to the growing feeling that the military and naval services of the country are not means invented for foolish men to lead idle lives, but require real honest work for their proper fulfilment, and are honourable just in proportion as they involve mental and bodily exertion and unselfishness.

English Officers and soldiers are always ready to fight and die for their country. It is harder to work for her day by day and to live for her. If we hold the military service honourable, if we flock to it, whatever be the pay, if we soldiers are accustomed to look for and find kindly welcome, respect and honour wherever we go, let us not forget that we have it all simply because when the time of need comes "England expects every man to do his duty."

The CHAIRMAN: Perhaps General Walker, who has had a great deal of experience in matters of this kind, would like to make some observations.

Major-General Beauchamp WALKER: I find, after the admirable lecture of my friend Captain Brackenbury, that I have but little to say; indeed, he has produced every point of interest connected with this very important question. I think, therefore, that I had better confine myself to that about which I know most, viz., the Prussian system. Captain Brackenbury most aptly said, that the basis of manœuvres on an extended scale is a thorough knowledge of our business from the commencement. One reason why I believe the Prussians have shown themselves such signal masters in the art of war is, that they begin by a thorough instruction of their companies and squadrons. Every Captain in the Prussian Service is the man who is responsible for the instruction and management of the body confided to him, whether it is a company or a squadron; and it is that company formation which has led to their great success. The one great question of the day, previous to this war—and in that, I think, Sir William Codrington will agree with me—at the last manœuvres which took place, was, "line or column?" and a very lively discussion it was. But even the line, as we hear from Captain Brackenbury, begins to show that it is hardly up to the requirements of the day; the column manifestly not—that is what we all think of as a column, the regimental column; *that* must simply fail in any attack in the open field at the present day. Where you have to advance in the face of a fire which is effective for twelve hundred yards, it is hardly possible that you can keep together a body of a thousand men in a column of eight companies or divisions, and bring them up to the scratch at last. That has been found simply impracticable, though that was the Prussian system adhered to long after other nations supposed it to be imperfect. They, therefore, fell upon the "company column" formation; and even that has been found in the late war almost too dense for efficiency. It has come now, as Captain Brackenbury said, to the swarm of skirmishers. Perhaps the greatest example which occurred during the war of 1870–71, was the attack of the Prussian guard on St. Privat, the right of the French line, on the 18th of August. I think in less than ten minutes the guard lost over 6,000 men, even advancing in the most extended order which they acknowledged to be effective, which was a line of company-columns joined by skirmishers, supported by half-battalions, and supported further in the rear by another line of battalion columns. Their subsequent attacks were made almost always in extended order. But you cannot fight in extended order, unless your men are thoroughly in hand, otherwise they become a mere mob, every one fighting for himself. But there is one point which I wish to impress upon everybody here, that, unless you have a thoroughly efficient system of instruction from the very commencement, by which the Captain (or whoever he may be), is the person who has taught his men, who knows every man under him, and is his actual leader, you never can command success. I, therefore, most distinctly enunciate that I believe the foundation of the great success of the Prussian army to be that system which gives great independence (I will not say to the subordinate Officers, for I do not consider a Captain a subordinate Officer, I consider him the most important Officer in the Service), which gives to the Captain, as commander of his company or squadron, the sole care and instruction of the men under him. He knows them, they know him, and, in the moment of trial he calls upon them, and they rely upon the person in whom they have confidence, and who has been their teacher from the very commencement.

General SIR WILLIAM CODRINGTON: The question that General Walker and Captain Brackenbury have mooted, that of fighting in line, is one of the most important for the British Army. General Walker will remember—I do not know whether Captain Brackenbury knows—that we visited the Prussian Army together, and we saw the system of "company-column" developed in their manœuvres. This was after the war of 1866, and before the war of 1870. I remember frequently having discussions with my friend, and also with Prussian Officers on the question of the advance of the "company-columns" under fire. I remember the very first occasion on which that question struck me as an English Officer: the skirmishers were sent out in advance, namely, one-third of 250 men, which is the number of a company, the remaining two-thirds were in actual column; that is to say, a large column of sections, so large as to be a good mark for artillery at 1,200 yards—I think we were agreed about that.—(General WALKER: Quite so.) I remember perfectly in the first attack on the village of Müncheberg that struck me, as an English Officer accustomed to feel that his attack is in line in order to save life and to give the greatest fire from troops when they have the opportunity of giving their fire, it struck one as a dangerous principle to adopt. Not only were those company columns within twenty-five or thirty paces of the skirmishing line (which may or may not have been a little too close for regulation, I am not aware how that is, but the fact was so), but the battalion was also in column, and very nearly the same twenty-five to thirty paces in rear of the company column. The English Officers who were there felt, "what is the enemy's artillery to do if it is placed at the windmill of the village?" which was just on the rise with the ground forming a glacis up to it, when such columns as those, the company column and the battalion column close in rear, are exposed to the active fire of the artillery of the present day. The advance of troops in column under fire was certainly of frequent occurrence in the manœuvres of 1869, in the Prussian Army, and if Major Roerdansz were present, I think he would confirm the fact that it was at that time the habit, or at least very much the habit, during the Prussian manœuvres. What have we heard since during the war of 1870? This very practice that took place in 1869, in peace, took place, I think, in the early part of the war of 1870 in France. I may be wrong, I was not there; but from what one has read subsequently, I think that same system was employed, and General Walker will, perhaps, be able to confirm it or not. But I believe that the Duke of Wurtemburg visited the battle fields of Spicheren, and the battle fields round Metz, in order to see how it was that the enormous losses had taken place in the Prussian Army. I think the facts have borne out the idea, that subsequent to the examination of the result of those actions, a total change took place in the attacks of the Prussian Army; they had attacked in bodies which were exposed to great loss, although the French artillery was not well served, but finding that those losses took place, they took to the skirmishing principle in a much greater degree, and made it the rule of their Service in the latter part of the war of 1870. I speak under correction, but I think I am right in these facts. But now I should like to put to the lecturer this, in any remarks that may be made afterwards. Was there any position of importance, such as at St. Privat or at Rezonville; was there any positive defencible position held by the French that was taken by skirmishers only on the part of the Prussians? I should rather doubt it. Skirmishing order, good as it may be for its purpose, is surely not that concentrated attack to which at last it must come; and then, if you are not to get your men together either for the purpose of firing or for the purpose of getting to close quarters with bayonets, I think there must be a difficulty in such open order attack. There is no doubt that the original line, what is called the standing-up line of England, may not answer; that is to say, people cannot stand up to be exposed to fire. But I want to know whether it has ever been the practice in the English Army to place men in line, almost according to present ideas, for the purpose of being exposed to fire? In the accounts of wars that one has read, and certainly in some that have taken place of late years, the line did not stand up; but when it was under fire, until the moment of action came, it lay down, and certainly was comparatively little exposed to fire on those occasions. What I want to get at from those who really think that the line is obsolete, is this: In the first place, take the Peninsular war; how was it that the line was so much used by the English Army? Was it not that the Duke of Wellington found that by placing men in line, having confidence in their fire and their steadiness, the fire of the whole was utilized, and would overlap the attack of a column? Therefore, the French armies generally on that account failed in their attacks against the English when they were in line. There is no doubt that is the fact; therefore, don't say the line is obsolete, when it is really a newer system than the column formation of the wars of Napoleon. There are, certainly later wars; still at that time was adopted the principle that holds good now, namely, that a greater quantity of fire can be given from line than from column; and as to exposure to artillery, the line is less exposed to casualties from artillery fire than any column, even a company column. I should like the lecturer to give us an account of the actual attack, at the heights of Spicheren, for instance; this was a steep isolated height looking over a valley. The Prussians advanced. If I remember the ground rightly, the Prussians advanced from Saarbruck down a slope and over a flat of about a mile and a-half or two miles, and then up this very steep height of Spicheren. I want to know how they crossed that open, whether they were exposed to artillery fire, and whether they were exposed to infantry fire, in column, because I believe there they lost a great number of men. There is no doubt that at St. Privat enormous losses took place. I should also be glad to know from the lecturer if he can tell us whether the division of Guards in advance from St. Marie-aux-chênes up that sort of open glacis to St. Privat, attacked in column. The first attack was foiled, but I think the attack succeeded afterwards with a great loss of men. Perhaps he would let us know as to the tactical formation of the troops on those occasions, and if these attacks were made in column exposed to artillery, in preference to attacking in line. That is the point about which I should be glad to get information, because it is a point of tactics more than of strategy, and it is of great importance to the future of the English Army. The pamphlet referred to is that of the Duke of Wurtemburg,—I don't know whether he is a Prussian Officer. (General WALKER: No, he is in the Austrian Service.) I quoted it for this purpose. He went to inquire how it was these losses took place, and it was in consequence of his report that the change in the Prussian system of attack took place.

Major-General Lord MARK KERR: I think I can answer Sir W. Codrington's question. I believe the reason of the excessive loss of life on the German side at St. Privat to be, that they attacked the French, straight along their front, and that their "swarm of skirmishers," to use the phrase of the gallant lecturer, was always too thick a swarm. On their left at St. Marie-aux-Chênes and St. Privat, they were brought up, swarm after swarm—not close enough where they would have been safer—but straight into the range of the French fire, only to be shot down one after another, literally strewing the ground "thick as autumnal leaves that strew the brooks." I believe the turning of the French right to have been a "pensée de l'escalier." The Germans had retired—had certainly ceased to advance for some time, when it was discovered that the French right, though it kept its ground, was without ammunition, and Canrobert, who commanded it, was obliged to retire in his turn. The German tactics were as bad at St. Privat as they were all throughout the war against the French Imperial Army. With overpowering numbers they employed the column covered by these swarms of devoted skirmishers, and they attacked in front. These tactics were changed later.

As I am speaking, I wish to make a remark on the subject of the lecture. There are two ways in which the autumn manœuvres might be of essential service. I mean in the training of our cavalry in outlooking and gaining information—the cavalry is the true intelligence department of the General—and in that of the light infantry skirmisher. But both these were wanting at the late manœuvres. It was a striking sight to witness as I did a line of skirmishers advance (the umpire looking on), and altogether regardless of it, move slowly across the open under a fierce opposing fire of skirmishers skilfully posted behind perfect shelter, and dislodge without loss their opponents, gaining an easy victory against all rules of mimic or real war and common sense. It was a curious sight to see the General of one army for some hours on rising ground surrounded by his staff gazing through telescopes into space in search of his antagonist, with the cavalry—which would have been able to bring him the information better than any number of telescopes—behind him, and while so employed, to hear firing somewhere back on his flank, and on looking for the cause to see it in the prominent features of an opposing General of Brigade gallantly emerging from hostile smoke, who was proudly riding into his midst, while the lines of infantry blazed blank cartridge into one another's faces and into those of the umpires at less than 100 paces distance.

I repeat that neither cavalry *éclaireurs* nor infantry skirmishers were used to any purpose at the late manœuvres. They did not act their part at all. On the particular occasion to which I refer, if the General had employed half a dozen men that could ride and use their eyes, he would have known exactly where the opposing force was. And as to skirmishing, except in the barrack square fashion, as a rule, they did not skirmish at all.

I fear I have spoken too long, but before I sit down I must say that there is one suggestion of the gallant lecturer which I think a famous one, that of the Admiral and his 10,000 men hovering on the coast with full discretion as to his point of attack. I can imagine the pleasing state of anxiety of some of the functionaries in Pall Mall during the carrying out of this plan of testing their departments. I can fancy I see the faces of Quartermaster-General and the Controller-General waiting in suspense as to whether the Admiral would disembark his 10,000 in Torbay or on the coasts of Northumberland or Norfolk.

General WALKER: Sir William Codrington was anxious for information on one or two points, which I think will interest others as well as himself. First, he enquired about the attack on Spicheren. One reason why the Prussians advanced to the attack on Spicheren with such impunity was that the French guns were too far back, drawn up behind the crest attacked; therefore, they got up to the heights without suffering while crossing the plain which lay between Saarbrück and the base of the heights.

Sir WILLIAM CODRINGTON: In column?

General WALKER: Always in column. But I can tell you the exact formation at Weissenburg, which was the first affair of the army I was attached to during the campaign. I saw it very plainly. They attacked in four lines. The first line were the fifth rifles.

The CHAIRMAN: You mean four lines of columns.

General WALKER: No, four continuous lines.

Sir WILLIAM CODRINGTON: The troops deployed.

General WALKER: Yes. The first were the fifth rifles in skirmishing order. The second line, as I am pleased to call it, though it is not what we should call it, were company columns, two companies from each battalion. The third line was formed of half battalions in support, and the reserve was a line of battalions.

General CODRINGTON: In column?

General WALKER: All in columns, except the fifth rifles and the connecting skirmishers of the company columns. That was the order in which they attacked. But they suffered so excessively from going up hill in columns, that they very soon threw the whole of what I will call the second line of company columns, into skirmishing order. They then attacked in two lines of skirmishers, the fifth rifles in front, and the whole of this line of company columns in line of skirmishers behind. The others coming at still greater distances, and holding their ground very carefully, kept out of fire in support and in reserve. Sir William is perfectly right in saying that the great loss experienced at St. Privat was from their attacking even in the modified form of "company-columns." But I think Duke William of Wurtemburg, who only came out after the battle, and who I hardly think has had the same opportunities of discussing the question since as I have had in Berlin (I only wish I could say all I know on the subject, or rather all that has been said to me), I think he was not quite right in two respects. I think he firstly attributed the whole of the loss, and the subsequent modification of their mode of attack, to the fact of their having attacked in column; and, secondly, I think he was not quite correct in the modification which he declared to have taken place. I am most confidently assured by one of those who commanded on that day, that the great reason of the loss was that the attack was not properly prepared by artillery; it was the improper use of artillery which led to the great loss. And the order issued in the army—(I never heard the order to which Duke William of Wurtemburg alluded)—but the order which I did hear was that no Officer commanding a corps on his peril should presume to attack a position held by the enemy in force, until he had prepared the way by artillery. That was the order issued to the army. I think Duke William of Wurtemburg must have been wrongly informed, or that he caught up an idea a little hastily, because I have had the opportunity of talking about this question until the day I came away from Berlin. But the real truth as to the attack on St. Privat will never be published in the lifetime of any of us; it will never be known. It can hardly be called a repulse. The men lay down until the artillery crushed the French artillery, and it was safe again for them to advance. That I believe is the plain truth, destitute of a great many facts that will never come out in our lifetime.

Lord MARK KERR: The French had no ammunition the latter part of the day.

General WALKER: That may be so. It is only to-day that one reads that Marshal Bazaine's excuse for not showing greater activity while he was shut up in Metz was, that the Army had only one day's ammunition when they were shut up in the fortress. I heard that fact during the campaign, and having seen it published during the last few days, it confirms what I heard at the time.

Sir WILLIAM CODRINGTON: Perhaps you will mention where the French artillery was placed between St. Marie-aux-Chênes and St. Privat, because, if I remember, St. Marie-aux-Chênes was at the bottom of the glacis. Was there any place where the French artillery could command the Prussian troops?

General WALKER: After all, what enabled the Prussians to take St. Privat was the Saxon advance on the village of Roncourt. If the artillery fire (I am only giving an opinion) had been continued until the Saxons had completed their turning movement, there would perhaps have been no necessity for this hazardous attack on St. Privat. But the day was drawing on, and troops do get impatient sometimes when exposed to heavy fire. There is one point which Captain Brackenbury mentioned, and Lord Mark Kerr also, which is very important (and which we must practise in future Autumn Manœuvres in England, because it is the life and soul of the operations of an army in the field); and that is a much larger and more extended use of cavalry than took place last year. The one important fact, beyond that discipline I spoke of before, the one thing during the last war which led to the great success of the Prussians, was the wonderful and unrivalled use which they made of their cavalry. Their cavalry were pushed not only miles, but days' marches ahead. No movement of the enemy was concealed from them, and no movement of their own was revealed to the enemy—they were simply covered by a veil of cavalry. In the old days, when I was a cavalry soldier, it was thought the sole *rôle* of cavalry in war was to execute magnificent charges, headed by their Commanding Officers. That was the only and sole object for which one sweated and drilled during the hot days of summer. I hold that the preservation of the army from surprise, and the discovery of the intentions of the enemy, is a far higher *rôle* for the cavalry soldier to play than that of merely charging in line. I hold that the wonderful intelligence shown by the Prussian cavalry in the late war, the careful organisation of the divisions under their Lieutenant-Generals, the mode in which they harassed the enemy on every point, in which they discovered his every movement, in which they cut his railways, in which they prevented his reinforcements coming up by destroying communications, is a far higher definition of the duties of the cavalry soldier in war than merely charging in line. I do sincerely hope that cavalry soldiers, who think that their day is past, will take heart by what I say; my belief is that a far greater sphere is open for cavalry now than in the old days when they rushed merely headlong against one another. I believe that our *rôle* in future is the intelligence, the concealment (I won't say the spy, but the *éclaireur*) department of the whole Army.

Major Baylis, 36th Middlesex Rifle Volunteers: Will you allow me to make one remark in confirmation of what has fallen from General Walker? I was present at the Autumn Manœuvres last year, and was struck with the absence of the assistance of cavalry, or mounted patroles, in connection with infantry regiments or brigades for the purpose of keeping up communications, &c. I was placed in a position, viz., in command as Captain of a flanking party, when it was reported to me that there were certain of the enemy's cavalry seen on the hills in the distance to the left, and that they had galloped off on seeing us. Being at a great interval from the main body, and not mounted, it was impossible for me to communicate that important information with the rapidity I could have wished. It seems to me that if we had connected with our infantry troops some eight or ten mounted patroles attached to each infantry brigade, who might convey intelligence, they would be of very great use in the service.

Colonel Sir Henry Havelock, Bart., V.C.: I would ask to be allowed to say a word with regard to the very interesting paper of Captain Brackenbury. One of the points he brought out was that, as we have happily been in the position of bystanders while war has been going on on the Continent, we have had the opportunity of learning at the expense of others. But while ready to profit by the experience of other nations, I think that we should not altogether ignore the fact that at all times in our history, from the earliest down to the present, when a great necessity has arisen, the genius of Englishmen has been equal to the occasion. It is in our traditions of former times that, when we were armed only with the long bow, the English bowmen were superior to those of all the world. In more recent times, we have had the good fortune to develop the powers of the rifle and long range artillery. I don't think we should be doing justice to ourselves if we did not say that our own people will be found equal to the occasion when the occasion arises. In the present instance, the experience of the Prussians only confirms our long cherished liking for line formations. With regard to the attack on St. Privat (the scene of which I had an opportunity of seeing immediately afterwards, though not present at the time of the attack), it resolved itself into the old vexed question of column *versus* line. The Germans had adhered to the column formation to a great extent, although modifying it very much. The column was the prevailing idea of the First Napoleon's formations for attack. The Germans had modified it considerably, adopting to a certain extent our line formation. Theirs was a sort of intermediate formation,—company columns supporting swarms of skirmishers. Their first line in the attack on St. Privat was a swarm of skirmishers; their second line was composed of company columns, but their main body was a line of battalion columns. (General Walker: That was the very expression I used.) The attack on St. Privat therefore failed, because it was made virtually in successive lines of column, their front line only being composed of skirmishers. In fact, their formation as regards depth was mainly one of column. Now there is an old English formation that I have heard discussed years ago, long before it was spoken of by the Prussians, but which now, since the pamphlet of the Duke of Wurtemburg, seems to be in favour with them also. That is the successive advance of alternate lines, close to each other. One in front, and one in rear, with about 100 yards distance between them; the front line moving at the double for a short distance, and then lying down and firing till overtaken by the rear line, which then passes to the front, and does the same in its turn. It seems to be the prevailing idea now among the Prussians that that may come to be the future formation for attack; that the front line will lie down firing, and that the lines in rear of that need not be formed of columns at all, but of lines in extended order, only separated from each other by a distance of 100 to 150 yards, covering the intermediate distance between lines, at the double, and then immediately lying down to fire. By that means, the line which is behind the skirmishing line, gradually creeping from point to point of cover in that way, can approach the point where its attack is required to be delivered without sustaining any heavy loss. It may, while lying down for two or three minutes just before the final attack, be reinforced by the line in its rear, or by the two succeeding lines in rear, so that the point of attack can be finally approached in as close formation as if the troops had advanced in column, while from the advance being really made in line, the troops hardly sustain any loss at all. Captain Brackenbury remarked that the movements of the cavalry at the last Autumn Manœuvres were open to criticism. But I don't think he did quite justice there to all the cavalry. For though the position on Fox Hills was crept up to, on the last day's fight, without the cavalry on the defending side giving any information to their General, still that very fact presupposes that the cavalry on the other side acted in the Prussian way of entirely masking the movements of their line until it was able to make a sudden successful attack. There is an Officer here, who I daresay would not like to have his name mentioned; but if he were at liberty to tell us in detail what the cavalry orders on the attacking side were, I think we should hear that the cavalry on that side did exactly what the Prussian cavalry did, only on a smaller scale, that is to say, that they were thrown out four or five miles in advance of their force, and that they screened completely the movements of their own side, until the troops behind them were able to advance and throw themselves unexpectedly upon the enemy's unprotected flank.

Captain BRACKENBURY: I have only a very few words to say in reply to the various remarks which have been made. With regard to most of the discussion, I think there is no reason that I should say anything at all, as most of the speakers supported my views. Sir William Codrington asked several questions about the attack on St. Privat. All those questions have been answered by General Walker. With regard to the attack on Spicheren, I believe that the Prussian advance across the valley was rendered easier than it would otherwise have been by the fact that the French were not provided with sufficient artillery; they had a very small proportionate force of artillery there, and the attack of the Prussians was therefore easy. Yet even on that occasion the attack was not successful until the flank of the French was turned. I think if we refer to the battles throughout the course of the war, we shall find that direct attacks upon positions in column or in line of company columns, were always unsuccessful, even when they had been prepared by artillery fire, until a flanking movement was made, sometimes by artillery only, sometimes by infantry, obliging the defenders to abandon their defensive lines of works. I believe such to have been the case as far as I have been able to ascertain by reading. I am sorry to say I was not there to see the first part of the war. Three special questions have been referred to in the discussion. First as to the fighting of cavalry, and their action in the past manœuvres, especially on the last day, the battle of Fox Hills. I do not think anything I said could fairly be taken as reflecting against the cavalry which advanced that day, still less against the brigade to which I had the honour to be attached at the time as Assistant-Umpire. I never saw anything more splendid in any warfare than the dash of the squadron of the 10th Hussars up that road into the middle of General Staveley's position. Rash it may have been, but the fact was that those men succeeded in going up to the plateau, and, as I rode up with them, I can vouch for the fact that though some of them would not have come back, they would have done the very work that I want to see cavalry do. They rode rapidly up the road to the top into the middle of the enemy's position; they would have come down *with information*, those of them who did come down, only they should never have been allowed such a chance. The action of cavalry should be dictated and supervised by the highest intelligence. No one requires more intelligence and knowledge of war than the cavalry Officer and the cavalry soldier. The kind of action which is now required of cavalry appears to me to be more chivalrous than the charges in mass which they had to make in the late wars; because now every man must be individually brave and wise; and the *rôle* which is proposed for them in future war is so much above the *rôle* which they have lately considered theirs, as the wit of a gentleman is above that of a clown. Some gentleman referred to the infantry requiring cavalry to be near them to give information of what was going on. Cavalry should be patrolling all the roads in front of infantry, but their information must go to the General or Brigade Commander. The Prussians always had large numbers of cavalry out in front of their Army; and, as General Walker remarks, not only miles but days' marches in front, while between them and the Army lines of communication were kept up, along which knowledge was always passing. We must in our manœuvres employ cavalry in the same way. But you cannot do it unless you have the two forces really manœuvring against each other—really getting information about each other; and, therefore, really acting as they would act in war. That is the only way to learn it. The second question I must notice was raised by Sir Henry Havelock, who said that the spirit of Englishmen would always be equal to the occasion, and their genius must be trusted to. I perfectly agree with him; but that is no reason why genius should be left uncultivated. The English have a genius for war; but we all know what becomes of genius, very often, when it is left to lie fallow. Without cultivation it produces only worthless weeds. Thirdly, with regard to this action of infantry in line and column. The only part of the war in which I was allowed to be present was the latter part. I was with Prince Frederick Charles on his attack on Le Mans, and, in order to learn as much as possible, I went with the advanced guards, and with the soldiers when making their attacks, so as really to see what were the latest ideas on tactics in the field. The work was done almost entirely by skirmishers. During the advance from Vendome, at the battle of Changé, and the three days' fighting before Le Mans, the same thing took place. The fire of the French was so awful that it was perfectly impossible for troops in any formation to live under it, though the French soldiers aimed very badly. In woods occupied by the Prussians, every tree had several bullet marks in it, and it would have been perfectly impossible for any thing in formation to have lived under such a storm. The only way in which the Prussians did live was by advancing in very loose order, by throwing themselves down, by dodging behind every hedge and bank, assembling in groups behind a house or little hill, and creeping on bit by bit as they could. Then, when they came near the enemy, the Captain of the company *who knew his men*, as General Walker said, saw his opportunity, seized it, and, calling his men to him, dashed in at that place. The moment he was in, that moment the French ran. I believe that some such system of advance is most likely to be adopted of necessity in the warfare of the future. Some one said that our lines would not stand up exposed to fire in war; but they certainly did stand up at the manœuvres. It was rather painful to see them sometimes, because they were being practically taught to consider that it is a grand thing, a brave thing, and a right thing for soldiers to stand up and face their enemy. Then, when it comes to war, they will find that they cannot stand up and face their enemy. They must lie down. They will say, "Here is all our bravery "gone! What our Officers have taught us is impossible." Now, if they were told from the beginning, "War is so changed that it is not the right thing to stand up, "you must now lie down, you must creep, you must make a different kind of business "of it;" the moment they go into war they say, "This is what we expected; the "fire is very hot; we are ordered to lie down, to creep." In fact, to avoid future demoralisation, I am anxious not to have at our manœuvres what we should not have in war, lest our time and money should be worse than wasted. I think those are all the points that I need refer to.

The CHAIRMAN: On behalf of this meeting, I propose a vote of thanks to the Lecturer for his very able paper.

NOTE.—By permission of the Council, I would add one word. Some Officers appear to think that the only substitute for the line is the column. I do not advocate a return to column formations under fire, but a development of the line, by using extended order for all attacks. I dread improvised looseness (like that of the French) before an enemy, and am anxious that the advance in extended order—not a mere line of skirmishers—should be carefully practised in peace, because it is inevitable in war. Then there will be no opening left for "looseness."—C. B. B.

LECTURE.

Friday, May 3rd, 1872.

Major-General W. C. E. NAPIER, Director-General of Military Education, in the Chair.

ENGLISH AND FOREIGN MAPS AND THEIR USE FOR MILITARY PURPOSES.

By Captain Charles W. Wilson, R.E., Director Topographical and Statistical Department, War Office.

Amongst the points connected with the recent war between France and Germany which attracted considerable attention at the time, were the supply of maps to the German Army, and the good use that was made of them. It is hardly necessary to mention that the popular belief, that every Uhlan rode about with a map in his hand, is incorrect. There appears to have been a liberal supply of maps, and what is far more to the purpose, the Officers in whose hands they were placed, knew how to make the best use of them. As an instance of this, it is only necessary to refer to Captain Brackenbury's description of the Prussian Officer, who, with the aid of a map, led his men without the least hesitation through an intricate district in Brittany that he had never visited before. The maps used by the Germans were reproductions of the Government maps of France, on the $\frac{1}{80000}$ and $\frac{1}{320000}$ scales, 0·792″ and 0·198″ to a mile.

Last year, whilst the general interest in military maps, created by the war, was still fresh, a map of the vicinity of Aldershot was prepared for the use of the troops during the autumn manœuvres, and a large number of copies supplied. It was only natural that the first map of any portion of this country which had been specially issued for what may be called "use in the field" should be freely criticised, and it was equally natural to expect that it would not please every one. Some objected to its scale and its colouring, whilst others complained of its want of accuracy and unsuitability for military purposes; in fact, there was no part of the map which was not attacked.

As any unfavourable comments on this map may be supposed to reflect, to a certain extent, on the character of the 1-inch map of England, of a portion of which it was a reproduction, it seems desirable to give those who take an interest in the question an opportunity of comparing the maps of foreign countries with those of our own. Such a comparison is the best method of removing the false impression that England is not still in advance of continental nations in the art and practice of accurate map-making, and the following paper will, it is hoped, show that many of the objections to the Aldershot map were due, partly to a misapprehension of the true object and capacity of maps, and partly to want of experience in the use of maps on a comparatively small scale.

It may, however, be advisable in the first place to say a few words on the general object of maps, and the use which may be made of them for military purposes.

The best method of acquiring a thorough knowledge of the natural and artificial features of a country is by personal observation, but this requires time and opportunity, which are not always available. We must, therefore, have recourse to maps which enable us to form a correct judgment on the general character of a country, and to arrange and carry out personal *reconnaissances* in a systematic manner. It must always be remembered that even when the very best maps are available, personal observation is most desirable, if not absolutely necessary.

Maps are, however, of little value unless we are able to understand, or, more correctly, read them. Our eye should be accustomed to the representation of ground on the reduced scales used in maps, and to the special arrangements for showing elevation or relief; our eye should also be trained to appreciate the value and meaning of conventional signs, and we should learn to find our position readily on the map when using it in the field.

This power of reading maps can only be acquired by constant and careful study in the field. Perhaps the best method is to take a map and compare it with the ground which it represents, commencing with a large scale, then taking a smaller one, and proceeding from an open easy country to a hilly and close one. The student should open out the map in front of him and adjust it by compass bearings, or with reference to prominent objects, such as steeples and isolated houses, and should then identify the more marked features, including main roads, lines of railway, &c. He should afterwards carefully compare the features of the country with their representation on the map, and train himself to estimate distances, first on the ground, then on the map, using the scale as a check to his eye. He should also examine in detail the features of some well-defined position on the ground and on the map, and follow some of the roads, estimating as he proceeds the angles at which cross roads branch off. By this means the eye becomes accustomed to the conventional character which all maps must have, and learns to appreciate their true object and value.

In considering the practical advantages which may be derived from maps, we should always remember that they cannot be expected to give more information than their scale admits of, and we should in all cases ascertain the date of a map, and whether it has been revised since its publication, as this influences in a great degree the reliance that can be placed on it.

Good maps give distances correctly, and usually represent all obstacles, as rivers, mountain ranges, &c., which might hinder the movement of an army; they thus enable us with great exactness to make dispositions for the march when at a distance from the enemy. When in contact with the enemy, the general direction only can be laid down in this manner; all details must be arranged on the spot. Maps should never be trusted when making arrangements for the movement of troops off roads, as there are so many obstacles, such as hedges, stone walls, &c., which frequently cannot be shown on account of the smallness of the scale. In selecting camping grounds, *reconnaissance* is absolutely necessary, but maps give much valuable information as to water, roads, proximity to villages, &c.

Maps are of great assistance in drawing up instructions for those *reconnaissances*, which form one of the most important duties in war, and for the work of an Intelligence Department they are invaluable; they are also extremely useful to the leaders of patrols, scouting parties, advanced guards, and flankers, and they facilitate immensely the difficult task of keeping up communication between detached parties and the main body, and between the columns of an army on the march. They are valuable, too, when making flank marches, surprises, and raids, and they furnish important data for the defence of rivers, defiles, and mountain ranges.

Maps on a large scale are of great use when the operations of a war assume a local character, especially in a mountain district; on outpost duty the lines of vedettes or sentries, with their supports, may be placed by them, and the patrols regulated. If sufficiently accurate, maps may be consulted with advantage when selecting a position for fighting a defensive action; they suggest the mode of strengthening the front, *points d'appui* for the flanks, communications in rear, &c., and they enable us to form general conclusions as to the employment of the three arms; it cannot, however, be too often repeated that a careful examination of the position on the ground is always necessary.

In fighting an offensive action, the general plan of the engagement, the direction of the advance, and the disposition for attack or retreat can alone be laid down with the aid of a map, always bearing in mind that it may be necessary to modify or completely change dispositions made in this manner. Details and the execution of the movements must be left to personal observation on the ground. The battle of Gravelotte is a good example of an offensive action, for which the dispositions were based on data derived from maps.

Such are some of the uses of maps in war, but they are also of value as a means of training in time of peace. I need not enlarge on their assistance in studying military history, merely remarking that it is desirable to have maps showing the state of the country, lines of communication, &c., as they existed at the date of the campaign. Maps may be used for obtaining a knowledge of the ground in the vicinity of garrison towns, for making arrangements for peace manœuvres, the training of troops in outpost duty and for service in the field, and for drawing up instructions for *reconnaissances*, such as those annually undertaken by Officers of the Staff College, and that made of Essex last year. Our larger scale maps might be employed far more than they are for instructional purposes; for instance, the plans of the 25-inch map might be used for explaining the defence and attack of villages, the mode of placing the sentries, supports, patrols, &c. The 6-inch map might be used for taking up a defensive position; a special idea for the attack might be given, and the defender asked to describe in detail the means he would take to meet it, the employment of the three arms, the line of retreat if defeated, &c., the position of the troops being accurately laid down on the map.

One of the most important uses of maps in peace is, in a military point of view, for the arrangement of those skeleton manœuvres which were introduced with such success into the German service by Count von Moltke, and which have since been adopted by Austria and Russia. A most interesting account of the manœuvres carried out by the Russian Staff last year is given in the *Revue Militaire de l'Etranger*, a paper which I am glad to mention here, as it is one of the most remarkable offsprings of the recent war. In these manœuvres a general idea is given—say the advance of an army into Russia on a certain point. The Staff have then to draw out in detail the dispositions which would have to be made to meet it, first with a map, afterwards on the ground, when any modifications which a personal examination shows to be necessary are made. The Russian Staff have commenced at the Baltic, and they propose following the Russian boundary to the Black Sea, so that in time they will have well thought out schemes of defence for any invasion of the western frontier. I believe somewhat similar exercises have been introduced into the Staff College, but why should we not go a step further, and introduce them generally? The Generals commanding districts in England might possibly undertake similar manœuvres with the aid of their Staff; there could be no better instruction in Staff duties for the Officers employed, and in time a mass of information of the greatest value would be collected. Take, for example, the case of a supposed landing in Essex: the measures which should be taken for meeting the enemy, the selection of a position for an action, the means of transporting the troops, the selection of supply depôts, &c., are questions of great interest, which could be worked out with a map and by personal examination afterwards. If this were carried out systematically in all districts, a complete scheme of defence might be prepared for every eventuality that could be reasonably anticipated.

Before concluding this portion of the subject I would add a word of caution against placing too much reliance on maps. If they are looked upon as indispensable in time of peace, and their use permitted on all occasions, it may lead to the great detriment of the service in time of war.

A few words may also be said with regard to those military sketches, which are invaluable in war, and which should always accompany a reconnaissance report. It is to be feared that too much importance is attached to the scale of shade now in use; the scale is an extremely good one, but it should not be too rigidly adhered to, as it tends to develop monotony in style. It is quite right that there should be a scale, and that everyone should be taught on the same system; but it is too much to expect, as some do, that all Officers can be taught to draw with such accuracy that anyone, by applying the scale, can tell the exact slope. There is quite as much artistic feeling in the proper rendering of a hill-sketch as there is in a landscape drawing, and this feeling should be encouraged. The great beauty of the sketches of the late Major Petley, our best Military draughtsman, is, that they possess in the highest degree, this artistic touch, though they may not be conventionally true. Rough sketches, such as those made by the German Officers during the late war, and described by General Walker in his lecture last year,* showing the positions of outposts, &c., are of great practical value to a large number of Officers, and they are within everyone's capacity. It is to be hoped that during the next manœuvres, the production of sketches of this nature will be amongst the means of training adopted, and that Officers may be instructed to lay down on the maps supplied to them the route of the regiment they belong to, its position in camp and in action.

It is extremely desirable that the non-commissioned Officers, especially those of cavalry regiments, should be instructed in the use of maps, and this can, perhaps, be best effected in the schools by means of the black board. The men might first of all be shown the manner of drawing the horizontal projection of a table with the articles upon it, and afterwards be told to draw it themselves, on different scales. They might also be taught the use of conventional signs and the mode of delineating ground in the same manner. A plan of ground near the station might be explained to them, and the method of placing outposts, &c., exemplified, and this instruction might be afterwards completed in the field.

Conventional Signs.—The use of conventional signs on maps enables us to give an amount of information which could not be otherwise shown; they should be simple in character, and not too numerous, otherwise the maps would become crowded with symbols, the meaning of which it would not be always easy to remember. There is a general similarity in the conventional signs of all countries; the foreign symbols are perhaps too complicated, whilst our own are hardly sufficiently numerous; for instance, no distinction is made between metalled and unmetalled roads on English maps. The conventional signs used on our military maps should, as far as possible, be the same as those of the Ordnance Survey; it is impossible now to alter the latter, and it would create great confusion, and be manifestly unwise to introduce a different system for military purposes. We should, therefore, confine ourselves to adding such symbols as are deficient in the Ordnance Survey system, or are necessary on a military map.

Photographic Processes.—The best maps of European countries are those produced by the Government surveys, and in the event of a campaign in Europe it would be of great importance to have the means of reproducing them rapidly and accurately for the use of the Army. For this purpose photography is invaluable, and various processes have been adopted in this country and abroad; it would be beyond the scope of the present paper to enter into minute detail, and it will perhaps suffice here to enumerate those now in use. In England maps are copied by photozincography; in Belgium by photolithography; in Italy by Avet's process; and in Austria by Heliogravure. The maps of France used by the Germans were, I believe, reproduced by photozincography, photolithography, and the anastatic process; the latter, not a photographic process, is well known, and frequently used in England. The art of reproducing maps by photography seems capable of still further development, and the well known Heliotype process might probably be used with advantage in certain cases. A photographic outfit, with apparatus for reducing, copying, and enlarging maps, and laying them down on zinc, should form part of the equipment of every army in the field. The manner in which despatches were reduced and printed on collodion or gelatine during the siege of Paris is an example of the value of reduction; and as a specimen of enlargement, I may refer to that now on the table, which is reproduced from our one-inch map on the three-inch scale; this gives all that is required for taking up a defensive position, and would save much labour in sketching. A process recently invented by Lieutenant Abney, R.E., may be mentioned here, as likely to prove of great value in the field; by drawing a field sketch with a specially prepared ink or pencil, it is possible to lay it down at once on a zinc plate, and print as many copies as are necessary; a hundred copies of an order or despatch written with the ink might be printed in two hours.

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* See Journal, vol. xv, page 823.—Ed.

Mounted Maps.—The best form of map for use in the field is that which is mounted on calico so as to fold in sections about 9 inches by 4½ inches in size. There is, however, one objection to this form, viz., the space between the several sections of the map. Attempts have been made to produce more serviceable maps by printing on calico, india-rubber, &c., but they have not as yet found much favour. The Belgian *Depôt de la Guerre* has issued some beautiful maps printed in colours on calico, and the Austrian War Department have made use of a new paper called *hanf papier* (hemp paper), which is light, tough, durable, and can be folded without mounting; but neither of these are so decidedly superior to the ordinary mounted map as to justify their sole use in its place.

Colouring.—Maps may be either printed in colours or coloured by hand. The use of chromolithography is attended by several difficulties, the principal one being that of expense. In a small country like Belgium it answers very well; but if our own Ordnance Survey maps were printed in colour, the expense, especially of revision, would be enormous, and there would be the additional difficulty of providing adequate storage room for the number of stones required. The colours used in chromolithography are generally too opaque, and obscure the detail, so that the map frequently loses more than it gains; it would therefore seem desirable for the present to restrict the use of chromolithography to special maps, such as those showing military districts, lines of telegraph, &c.

Some interesting and beautiful maps have been produced in Austria on General Hauslab's principle of printing strata of elevation between 1,000 and 12,000 feet in different colours or tints of the same colour, the lowest height being light, the highest dark.

The great secret in hand colouring is to keep down the general tints and give prominence to the most important features in a military map. These are the rivers, lakes, roads, railroads, telegraph lines, woods, and buildings. Anything which obscures the hachures is bad, and for this reason it seems undesirable, as a general rule, to colour arable and pasture lands.

Aldershot Map.—The objections to the map of Aldershot are chiefly four: viz., its small scale, its want of accuracy, its unsuitability for military purposes, and its defective colouring.

First, as regards scale: there seems, I think, to be some misconception as to the scale of maps required for service in the field. The maps that should be issued are—

1st. Maps on a scale of from 3 to 6 inches to a mile of the environs of fortresses for siege purposes.

2nd. Maps on a scale of from $\frac{3}{4}$ of a mile to $1\frac{1}{4}$ mile to an inch for the use of the Staff, for detached parties, and for *reconnaissance* work.

3rd. Maps on a scale of from 4 to 6 miles to an inch for general issue to Officers commanding regiments, batteries, &c.

4th. Maps on a scale of about 10 miles to an inch, showing the main lines of communication and the principal military features.

Large scale maps are all very well for purposes of instruction and study, for laying down the position of troops after an action has been fought, and sometimes for taking up a defensive position, but they are far too bulky for general use in the field. As an instance of this, we may take the case of the recent war, during which the German operations extended over more than 100 sheets of the map of France, on a scale of $\frac{1}{80000}$, about $1\frac{1}{4}$ mile to an inch, and there was at one time a probability of their extending over a much larger area. When we consider that the number of German troops actually under arms in France in the month of February, 1871, was 1,350,000, we see that it would have been almost impossible for any department to produce a sufficient number of copies of a map on this scale for general issue to the Officers, and the addition in weight and bulk to the baggage of the army would be greater than any General would allow. The supply of maps on the 1-inch scale must therefore always be limited; and in the present day, when battles are fought on such a large front, it would be very inconvenient for a General to have a map on a scale like that of 6 inches to a mile spread out in front of him.

It has been said that the 1-inch scale is too small to give the information required on active service, but this is, to say the least, doubtful. No one would think of using a map for tactical movements, and for all other purposes information which cannot be conveyed by a map on the 1-inch scale should be obtained by personal observation. It may also be noticed with reference to our own 1-inch map that, as it has been completed, and the other scales, 6-inch, and 25-inch, have made considerable progress, no Government will entertain the idea of publishing a military map of the country on a separate scale, whether it be 2, 3, or 4 inches to a mile, for each of which there are numerous advocates. The 1-inch map is that which would be placed in every one's hands in the event of active operations in this country, and it is the one which should be carefully and attentively studied in time of peace.

2nd. *Want of Accuracy.*—There was a certain degree of justice in this complaint, as the map had only been partially revised since its first issue in 1813. The omissions were chiefly confined to some new roads, buildings, &c.; the hills, high roads, and main features remained unaltered, so that the map could be read with perfect ease, and any one who could not work with such a map in his hands would probably be equally at a loss with the best map in existence. Had there been an opportunity, the map would have been examined and corrected before issue, but the time between the selection of the Aldershot district and the commencement of the manœuvres was so short, and the demands for copies were so numerous and pressing, that it was only possible to take a direct transfer from the old map. The Officers of the field force appear to have taken it for granted that an Ordnance map, irrespective of its age, must be correct, and possibly for this reason it was not considered necessary to submit the map to that close personal examination which all maps require when operations are being carried on.

The great difficulties in the way of producing a revised edition of the old 1-inch map of England, and the serious nature of the whole question of revision, are not generally known. The changes in many parts of England have been so great that it would be necessary to re-survey them, and to make such large corrections on the copper plates, that it would be cheaper and easier to re-engrave the whole plate; it has therefore been deemed advisable to leave the 1-inch map as it is at present, merely inserting new lines of railway, and to publish an entirely new map* as the Cadastral, or 25-inch survey, progresses. This will cause some delay, but will in the end give us an almost perfect map.

It may be interesting to mention the system of revision in some foreign countries. In *Austria* maps are revised by the Survey Department, but a proposal has been made to employ the Staff Officers of the military districts on the necessary field work. To save making constant alterations on the copper plates, the corrections are printed on tracing paper, whence they can be easily transferred to the old maps. The map of *France* is periodically revised by Officers of the Staff, and in *Germany* the revision is also kept up by the general Staff. In *Russia* the maps are kept up to date by special detachments of the Topographical Corps, and two or three districts are revised annually. Would it not be possible in England for the Staff of each military district to keep the revision of so much of the 1-inch map as concerns them up to date? the labour of making the corrections would, after the first revision, be extremely slight, and if the map in the Head-quarters' Office were examined on the ground once in every five years it would answer all purposes.

3rd. *Unsuitability for Military Purposes.*—There is truth in this objection also, as although the one-inch map was originally commenced as a military map, sufficient prominence has not been given to military features in its production, and, as stated above, the time available was too short to allow any additions to be made to the map issued for the manœuvres.

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* Specimens of this map were shown at the meeting.

The Ordnance maps having, for many years past, been constructed with the paramount view of their general utility to all classes in the kingdom, purely military symbols have been omitted to a large extent, so that they might not confuse or take the place of other valuable information of a general character.

The military character of our one-inch map has, in fact, had to give way to the civil requirements of the state, and it is this which makes it in some respects inferior to the maps of foreign countries, which are prepared with a view to their military rather than to their civil use.

The sheets recently published of Scotland and the north of England are a great improvement on the older ones, and the new one-inch map will be still better, though it will not give all we require in a military map. As we cannot expect to have a map of England especially prepared for the use of the Army, we should try and adapt the existing one to our purposes, by adding to it such information as may be necessary, and this might perhaps be effected, as well as the revision, by the Staff of each military district.

In revising and completing the one-inch map for military purposes the following points should be attended to :—

Terrain.—As far as the scale admits of it, everything should be shown on manœuvring ground that can retard or facilitate the movement of troops, and altitudes should be inserted on the crest of all hills, and in the beds of ravines and valleys.

Roads.—New roads should be inserted and classified in accordance with the conventional signs used on the Ordnance Survey, those which are metalled being distinguished by colour from those which are unmetalled. Cuttings, embankments, bridges, viaducts, &c., should be shown, as well as foot and bridle paths, when of military importance.

Railways.—All new lines should be inserted, and a distinction made between single and double lines of rail, and between horse and steam roads. Cuttings, embankments, bridges, viaducts, tunnels, &c., should be shown, and stations built of stone distinguished from those of wood by using the letters S and W.

Towns and Buildings.—New buildings of military importance should be inserted, the outline of towns, villages, &c., with their gardens accurately marked, and the most important streets well shown, even at the expense of side streets. Churches and other buildings of importance should be made distinct, and inns, posting houses, mills, &c., distinguished by conventional signs; on coloured plans a distinction should be made between stone and wooden buildings.

On active service the number of houses or population of each village should be inserted, as a fair estimate of its resources can be made from either.

Lines of Telegraph should be shown by a conventional sign or by a yellow line.

Woods and Cultivation.—The limits of woods, shrubberies, hop gardens, and other kinds of cultivation which might influence military operations, should be well defined. Swampy woods should be marked as swamps, and a distinction should be made between woods of coniferous and those of foliferous trees.

Rivers, &c.—Streams which form a military obstacle should be distinguished from those which do not, by colour, or by representing the former by a double line. the latter by a single one. All hydrographical features, to the smallest swamp, should be shown, with the banks, when of military importance, and the means of crossing them. Iron, wood, and stone bridges, ferries, fords, dykes, water mills, wells, &c., should be distinguished by proper signs.

In rivers the limit of navigation should be marked, both for ships and for boats. It is also very desirable that the soundings should be inserted along the coast line from the Admiralty charts, as at present anyone taking up the question of coast-defence has to work with several maps on different scales.

4th. *Colouring.*—A limited number of coloured maps were issued for the manœuvres; they were originally prepared for the use of the Consultative Commission, and the defective colouring arose from an attempt to show too much on them. They were expected to give much information that would not be necessary on a military map; strong tints were used to bring out the several features, and the result was not at all satisfactory.

Special maps hardly come within the scope of the present paper, but specimens of road, railway, telegraph, and "Kriegsspiel" maps are on the table for the information of any one who wishes to examine them.

It now remains for me to review briefly the maps produced by the governments of European States.

Austria.—In Austria there is a cadastral survey on a scale of $\frac{1}{2880}$, or 22″ to a mile, the MS. plans of which are deposited in the office at Vienna. Copies are supplied to landed proprietors on payment. The published scales are—

$\frac{1}{14400}$ (4·4″ to a mile) for plans of battle fields, reconnaissances, &c.

$\frac{1}{28800}$ (2·2″ to a mile) for the vicinity of garrison towns, and other military purposes.

$\frac{1}{86400}$ (0·733″ to a mile) for the military map of Northern Italy.

$\frac{1}{144000}$ (0·44″ to a mile) for the military map of the Monarchy.

$\frac{1}{288000}$ (0·22″ to a mile), and the map generally known as Scheda's, on a scale of $\frac{1}{576000}$ (0·11″ to a mile).

The ground, which is occasionally treated a little too conventionally, is represented by vertical hachures on all the scales; the new map of Hungary, now in course of publication, is characteristically drawn and very well engraved. The survey is made with the plane table on a scale of $\frac{1}{28800}$. The want of a map on a scale between $\frac{1}{28800}$ and $\frac{1}{144000}$, has been felt so much since the war of 1866 that the Austrian War Department has decided on publishing a map of the whole monarchy on a scale of $\frac{1}{75000}$ (0·845″ to a mile), rather smaller than our one-inch map.

Road, railway, and other special maps, are prepared on various scales; many of them are printed in colour, and are very effective.

Belgium.—The cadastral survey is on a scale of $\frac{1}{2500}$ (25·344″ to a mile). The maps published by the Depôt de la Guerre are—

1. On a scale of $\frac{1}{20000}$ (3·168″ to a mile), printed in colours, the ground being shown by contours at one metre intervals. This map gives the most detailed delineation of ground of any map in Europe, but there is a want of uniformity in its execution. In printing the plans from six to seven stones have to be used, and this, of course, involves additional labour and expense, especially when corrections have to be made; as specimens of chromolithographic printing the plans are unsurpassed.
2. On a scale of $\frac{1}{40000}$ (1·584″ to a mile), engraved on stone; the ground is shown by contours at ten metre intervals.
3. Maps on various scales for special purposes.

The survey is made by Officers, principally from the infantry, with the plane table.

A good general map of the country, on which the ground is represented by vertical hachures, is published by Vandermäelen on a scale of $\frac{1}{80000}$ (0·792″ to a mile).

Contours are mathematically correct, and are of service in surveys on a large scale, but they do not give all that is required in a military map, and should be looked upon rather as auxiliary lines for the delineation of ground, than as furnishing such delineation themselves. They illustrate the distribution of high and low lands, but they are incapable of giving the minor modulations of the ground, and are less graphic than the topographical map, which is the only one that gives a good interpretation of the features of a country.

Contours at 100′ intervals often omit important changes of level, and cannot indicate the features of the ground, as a comparison of the two sheets of the one-inch map of Scotland now on the table, one with hill shading, the other with contours, will serve to show.

Denmark.—There is a cadastral survey on a scale of $\frac{1}{4000}$ (15·84″ to a mile), but the plans are not published.

The maps issued are—

1. On a scale of $\frac{1}{20000}$ (3·168″ to a mile). The ground shown by contours at 5′ intervals.
2. On a scale of $\frac{1}{80000}$ (0·792″ to a mile), with contours at 10′ intervals.
3. ,, $\frac{1}{160000}$ (0·396″ to a mile) ,, 30′ ,,

The survey is one of the most exact and trustworthy in Europe, and the maps are well executed, but the 10′ contours on the $\frac{1}{80000}$ map are not capable of rendering the features of the ground truly, and it is difficult to unravel the multitude of minute lines; the same may also be said of the $\frac{1}{160000}$ map. As the Danish islands have but small elevation, hachures would have given a better representation of the ground.

France.—The cadastral survey is on a scale of $\frac{1}{2500}$ (25·344″ to a mile), and the plans are kept in MS.

The government maps are—

1. On a scale of $\frac{1}{80000}$ (0·792″ to a mile). The map is prepared in MS. on a scale of $\frac{1}{40000}$ (1·584″ to a mile). The difference of level is shown by numbers, and the features by vertical hachures.

2. On a scale of $\frac{1}{320000}$ (0·198″ to a mile). The ground shown by vertical hachures.
3. Maps on various scales for battle-fields, &c.
4. Map of Central Europe on the $\frac{1}{320000}$ scale, printed in colours. Though said to be kept to date by the French staff, it is often inaccurate.

The execution of the sheets of the map of France varies; some of those recently issued are treated in an extremely artistic manner, but others leave much to be desired. The slow progress made in issuing the sheets is perhaps due to the difficulty of engraving the Alps, so as to give their proper character and relief.

Germany.—Prussia has a cadastral survey on a scale of $\frac{1}{2000}$ (31·680″ to a mile), of which only certain plans are published. In the Eastern Provinces the military survey is made on a scale of $\frac{1}{25000}$ (2·534″ to a mile), and published on the $\frac{1}{50000}$ (1·268″ to a mile), and $\frac{1}{100000}$ (0·634″ to a mile). In the Western Provinces it is made on a scale of $\frac{1}{20000}$ (3·160″ to a mile), and published on a scale of $\frac{1}{80000}$ (0·792″ to a mile).

The ground is represented by vertical hachures, and on the $\frac{1}{50000}$ scale, contours at 25′ intervals are printed in red over the hachures. The maps are clear and well executed, and due prominence is given to military features of importance.

An excellent map, on which the hills are well rendered and artistically treated, is issued by the Bavarian Staff, on a scale of $\frac{1}{250000}$ (0·253″ to a mile).

Several excellent maps of Central Europe are published by private firms in Germany; of these, Stieler's ($\frac{1}{740000}$), Reymann's ($\frac{1}{200000}$), Kiepert's ($\frac{1}{1000000}$), and Liebenow's ($\frac{1}{225000}$), were well known in England during the war of 1870–71.

Great Britain.—The maps prepared by the Ordnance Survey are:—

1. The cadastral, or parish survey, on a scale of $\frac{1}{2500}$ (25·34″ to a mile).
2. County survey, on a scale of $\frac{1}{10560}$ (six inches to a mile).
3. General map, on a scale of $\frac{1}{63360}$ (one inch to a mile).
4. Town maps, on various scales.
5. Special maps, on various scales, for War Department purposes.

The ground is represented on the one-inch map by vertical hachures, and on the six-inch map by contours at 5, 10, 25, 50, or 100 feet intervals, as circumstances may demand. Where the intervals between the contours are more than 25 feet, many of the minor modulations of the ground are lost, and the 6-inch map would be more useful for general military purposes if the hill features were shown by hachures, as in the specimen of the Surrey Hill map now before you.

The British survey is the most mathematically accurate in Europe, and as specimens of engraving, the sheets of the 1-inch map are unrivalled.

Holland.—The topographical map of Holland is made on a scale of $\frac{1}{25000}$ (2·534″ to a mile), and published on a scale of $\frac{1}{50000}$ (1·267″ to a mile). The survey is carefully made, but the execution of the sheets leaves much to be desired. The Dutch Topographical Department has issued some beautiful specimens of chromolithography, of which the map of Java, and special Waterstaats maps, printed by Colonel Bessier's process, are particularly worthy of notice.

Italy.—In Northern Italy, the Austrian map, on a scale of $\frac{1}{86400}$ (0·733″ to a mile), is generally used; and Sardinia has a map on a scale of $\frac{1}{50000}$ (1·267″ to a mile), with the ground shown by vertical hachures. A new survey of Sicily, on a scale of $\frac{1}{25000}$ (2·534″ to a mile) has been completed, and that of Southern Italy is now in progress. The sheets are published as photographs on a scale of $\frac{1}{50000}$, and on a scale of $\frac{1}{100000}$ (0·634″ to a mile), by Colonel Avet's system of photogravure; this process is the best of its kind in Europe, and the maps are masterpieces of applied photography. On the manuscript maps the ground is shown by 10′ contours, and the state of the cultivation by letters, which offer no compensation for the usual conventional signs, and cause a want of life and warmth in the map, which detracts from its general effect. The sheets on the $\frac{1}{100000}$ scale have been reduced directly from the originals, instead of from a special map, on which the "details" had been recast for reduction, and the result is that it cannot be read without a glass.

Russia.—There is a cadastral survey of certain districts on a scale of $\frac{1}{8400}$ (7·543″ to a mile), but the plans are not published. The maps issued are—

1. District maps on a scale of $\frac{1}{84000}$ (0·754″ to a mile).
2. Military topographical map of the Empire on a scale of $\frac{1}{12{\cdot}6000}$ (0·508″ to a mile .
3. A general map of the Empire, on a scale of $\frac{1}{420000}$ (0·151″ to a mile), printed in colours.

The features are shown on all the maps by vertical hachures, and the ground is well rendered on the small scale, but the drawing on the larger scales is not so satisfactory.

The use of the Russian language on the maps is inconvenient, but, thanks to the international language of symbols, they can be read with little trouble.

Sweden and Norway.—Maps of certain districts are published on a scale of $\frac{1}{20000}$ (3·168″ to a mile; the general maps of the country are on a scale of $\frac{1}{100000}$ (0·634″ to a mile), and $\frac{1}{200000}$ (0·317″ to a mile). The maps are printed in colours, and are clearly and characteristically executed; but the combination of vertical and horizontal hachures for the purpose of delineating mountains over 5,000 feet in a different style, is not very happy.

The new map of Norway, on the $\frac{1}{100000}$ scale, is very good; it is printed in colour, a style peculiarly suitable to the features of the country; the uncultivated tracts are tinted according to their steepness, whilst the gentler slopes are shaded on Lehman's system. It is also proposed to insert equidistant contours.

Switzerland.—The maps published are—

1. On a scale of $\frac{1}{25000}$ (2·534″ to a mile), printed in colours; the ground is represented by contours at 10 metre intervals.
2. On a scale of $\frac{1}{50000}$ (1·267″ to a mile), printed in colours, with contours at 30 metre intervals.

3. On a scale of $\frac{1}{100000}$ (0·634″ to a mile), with the ground shown by vertical hachures.

The maps are clear and well executed; that on the $\frac{1}{100000}$ scale is extremely beautiful, and as a specimen of cartography is probably the best in Europe. There is perhaps a little too much detail, and in places the names are sometimes obscured by the hachures.

Conclusion.—In conclusion, I must apologise for having introduced to your notice a rather dry subject, and for not having been able, from press of other work, to devote to it as much time as I could have wished. I have endeavoured as far as possible to avoid the more technical part of the subject, and must excuse myself for trespassing on your time by the importance I feel maps play in war, the wish that all Officers should be familiar with them, and that they should be used as extensively as possible.

With a good map, a watch, a telescope, and a few tried men, an Officer may start full of confidence on the most difficult mission that he may be ordered upon, feeling that an intelligent performance of the duty may prove the salvation of the Army, and decide the result of the war.

The Chairman: Gentlemen, this Lecture is to be followed by a discussion, therefore, if any gentleman has any observations to make we shall be happy to hear him.

Colonel Alcock: The Lecturer has expressed a fear that the Lecture which we have just heard has not been very interesting; but it is really of the greatest interest; and I believe that all present, and particularly the Members of this Institution, will desire to offer their thanks for so much useful information, and for the very agreeable manner in which that information has been conveyed. A proof that such information is interesting to the Members is, that we have a topographical department in the Institution, which contains both the newest maps and some more ancient ones, which served for the study of war of the last century. I may likewise mention, as connected with this subject, that we have made it a practice to mark the positions of the great events of the moment on our maps, because it has been found that in the progress of a war many places which become of great strategical importance are of very little importance upon the map, and, therefore, are difficult to find on some maps; while upon others, from the similarity of names, they may be found in two different places, or, in some cases, they may not exist at all. This unavoidably gives rise to uncertainty and trouble, and it was, therefore, thought desirable that in our topographical department, we should, by making the necessary references, do, carefully, for all, what each individual Member would otherwise have had to have done for himself, perhaps imperfectly, and sometimes with considerable loss of time. Although it may not be thought to apply to the subject immediately before us, yet I may be allowed to mention a recent instance in which the utility of this practice was shown during the late Franco-Prussian war: every movement of the troops was marked with such peculiar accuracy, that when the map was seen by the person practically the best able to judge, the gallant Crown Prince of Germany, when he did us the honour of visiting the Institution, I am informed that he expressed his surprise; and when it was suggested to him that there was a mistake at a particular place, he said "far from it; there is no mistake, the advanced guard was one march in advance at the time when there was an alteration in the line of march." He was gracious enough to pay us some high compliments upon the accuracy with which positions were marked upon our map; and these compliments were, I believe, not undeserved. That map is a remarkable record of the industry of Mr. Sullivan, to whom we are indebted for his attention to it. We have to regret that it cannot be photographed, and it must, therefore, be ultimately lost. In proposing a vote of thanks to Captain Wilson, I hope I may be pardoned for having intruded upon your time by mentioning the circumstances which have rendered his lecture peculiarly interesting to us.

Lieutenant-Colonel MIDDLETON, Superintending Officer of Garrison Instruction: Mr. President, as the Lecturer spoke about maps for autumn manœuvres, I should like to ask him one question, which I am the more emboldened to ask by his having stated that he thinks there is a fear of too much stress being laid upon the new system of scale of shade. I wish to ask him whether he thinks the scale of shade system is adapted for the maps of the ground on which autumn manœuvres take place. My reason for asking this is, that there was a map supplied to the Generals and Staff at the late Volunteer Review at Brighton on the scale of shade, and very few Officers could understand a bit of it, simply because the scale of shade was a new thing, and the elder Officers who were able to read maps in the old style were unable to read these, and they were, therefore, perfectly useless. One of the difficulties of the scale of shade, except to any person really cognisant with it, is to distinguish the top of a hill from the bottom. I have been accustomed to this system myself, but I had some difficulty the other day in deciding at once on one of those very Brighton maps, when I was asked which was the top and which the bottom of a hill; and though I do not set myself up as an authority, my doubts were shared by one who is no less a person than the Director-General of Military Education, who himself had to look twice before he was quite certain at a moment's notice as to whether it was a plateau or a valley. I should, therefore, like the lecturer to say whether he really thinks the new scale of shade is adapted for this purpose. With regard to Non-commissioned Officers, I believe the Director-General will tell you that steps have been taken to supply the instruction alluded to by the lecturer. As to the suggestion of correcting maps, which I think a very good one, I would beg to point out that the Staff of a Division in peace time is generally fully occupied without going over the country correcting maps, and I think there will be found the same with regard to Engineer Officers. But I fancy there can now be found at every station regimental Officers who are quite competent to correct maps if they have them supplied to them, and are sent out and regularly told off to certain districts under the supervision of the Garrison Instructor. The only difficulty that would arise is the old one, that generally stands in the way of everything—which I am afraid is an important one in this case, viz., that of money. These Officers might not have horses of their own, and there comes the question as to whether they could be furnished with Government ones for the time, or be granted an allowance. If either plan was adopted, I think there would be very little difficulty in the matter.

General SIR WILLIAM CODRINGTON: I think the general fault of English maps, as compared with foreign maps is, that they are too dark. There is a great deal of black printing which makes the English military map unfit for military purposes, compared with foreign maps. Take the maps of Switzerland. I daresay there are many present who have walked through Switzerland with Keller's map. It is a very mountainous country, and yet any person who has been there with a knapsack, knows where to find the top of a hill and the valley, the village, the bridge, the pass, and footpath all marked on the map. Yet it is a very simple and light-coloured map; there is no confusion about it. What we generally put into our English maps is too heavily engraved, and this makes them too dark and confused. One of the marked characteristics of *Scheeling's* map of Germany, is its clearness and lightness of engraving. It is quite sufficient to mark the hills, their height and steepness must be comparative in the man's mind who is looking at them. You cannot have them all excessively dark. As long as the hill is actually marked, and you can know the top of a hill from the valley, you don't want to have it very black. That is really the fault of all English maps. I see also in the new specimens of the one-inch Ordnance Map, the hills seem to be marked in rather too dark. I hope this is not a necessary part of that engraving, because when all the villages, the names, roads, &c., are put in, the dark printing makes confusion; but the one-inch map seems to be by far on the best scale. It is perfectly clear for almost anything an Officer wants, and certainly gives all the features that are wanting in a military point of view.

Sir HARRY VERNEY, Bart.: It has occurred to me that one defect in the Ordnance maps is the want of any means of finding out from them the inclination of hills, whether one hill commands another; and this appears to me to be rather a serious evil. Whether it has been corrected in the new Cadastral map I have not had the opportunity of seeing. The contour maps supply the want, by being marked with lines of identical elevation, the lines being at a certain fixed height above each other, say 10 to 20 feet, with thicker lines or red lines at a certain given height, say 100 to 200 feet. Another objection is, that the shading of maps is not uniform, some are much darker than others. So that when you put different squares together, you cannot tell the comparative height of hills, unless the shading of all the squares is equal; you cannot be sure that the proportion is kept between one deviation and another. The lecturer said that Officers engaged on coast defence are unable to learn from the Ordnance maps what is the depth of water near the shore; but I believe that it is universally laid down on the Admiralty charts. There may be a sufficient reason for that—the Ordnance maps may be bought by our enemies. Whether the Admiralty charts are published I know not.

Sir William Codrington: I believe the Admiralty charts are published and sold to any person who chooses to buy them.

Admiral Sir Frederick Nicolson, Bart.: I should like to confirm Sir William Codrington's remarks about the Swiss maps. I was, when a boy, at a school in Switzerland, and I have in my possession a map which I had then, and with which I have walked through Switzerland on many occasions. It is admirably clear. I wish to ask the lecturer whether in any maps there is a sign or figure to show the depths of rivers. For instance, if an Officer knowing the country well should happen to come upon the Thames in any part of its course, could he tell at once the average depth. I am not referring merely to fords, because I daresay they would be marked, but to other parts of the river. It would be useful in many military operations to know how far up a river a vessel of a certain size and carrying a certain weight of cargo, could go.

Major-General Beauchamp Walker: The observation I am going to make may perhaps rather surprise you as coming from myself, but what has fallen from the lecturer to day, from Sir William Codrington, and others, emboldens me to make the assertion that we all expect too much from maps in England. Because maps were found very useful, we fancy that maps can supply every want in war. I doubt very much whether maps, excepting to the general staff, as Captain Wilson says, for the purpose of taking up ground in the investment of fortresses, in preparing defensive positions, in perhaps throwing out the idea of great general concentrations which must take place on a particular point, are of much use for *tactical* purposes. Tactical movements are so quick, and a man has so much to think of at the time he is engaged in directing them, that he must be a very apt reader of a map who can form any clearer idea from that map than he will from the appearance of the ground before him. But the study of maps will enable a quick and clever man almost invariably, particularly if he has any knowledge of geology, to tell what style of country lies before him after he has got beyond the range of his own vision. There is where I think study of maps is so very useful in increasing the intelligence of Officers in the field; but that they can actually use them for the tactical movements of the day, I very much doubt.

Sir William Codrington: There is one point which I might perhaps refer to, viz., "the contour lines." The contour lines seem to me, looking at maps merely as showing the country, as infinitely less clear in giving the ground than the old line military drawings. I don't know whether it is established as a rule that contours are to be used in the new maps, but certainly as far as those are concerned who do not want to know accurately the exact elevation, but who do want to know the general features of the ground and the comparative elevation, I think the common usual line-drawing of hills is more clear than contour lines.

Captain Wilson: There are a few remarks which I should like to make on the scale of shade as applied to the Brighton map. I did not intend opening any discussion on the scale of shade, as that question was settled long ago; my intention was to confine myself to the maps issued by the Governments of our own and foreign countries. Perhaps one reason for the indistinctness of the Brighton map is the haste with which it was prepared. It may be remembered that there was some difficulty in making arrangements for the review, and in consequence of this, the field sketch, which was at one time stopped, only came into the lithographers' hands a few days before it was necessary to issue copies. The result was, that the lithographer was pressed for time, and though the drawing is accurate and in accordance with the scale of shade, the sketch is wanting in character. The scale of shade introduced for the six-inch scale is not, I think, applicable to smaller scales, such as the three-inch. With reference to the correction of maps by Officers, I am sure every one would be grateful to any Officers who would undertake the work; I mentioned the District Staff, as I presumed the General commanding and his Staff would be most interested in obtaining a correct map of the district in which they are serving.

With regard to Sir William Codrington's observations on the manner in which the hill features are represented on the one-inch map of England, I may remark that as all the sheets could not be drawn by the same person or engraved by the same hand, there must necessarily be some difference in style. Several of the sheets were drawn before the close of the last century, and it is a most curious study to examine the sheets from south to north, and trace the progress that has been made during the last 70 years in hill sketching and engraving. Though the styles differ, the drawing of the southern or older sheets is extremely good, and the hill features are well rendered. The blackness complained of is due to the system adopted by the Ordnance Survey of introducing light from the north-east corner of the sheet to produce artistic effect; this throws one side of the hills into shade, and tends to obscure the detail. I think myself it would be more satisfactory to adopt a scale of shade or uniform system of shading, and not to introduce light and shade. Sir Harry Verney remarked on the absence of heights on the old map; this has been rectified on the sheets recently issued, which give more altitudes than any other map in Europe. The question of contours *versus* hachures I leave to the specimens of the map of Scotland now before you; I may, however, mention that on the new one-inch map it is proposed to print the hill features over the contours, and that the latter can be easily strengthened by hand should it be considered desirable. Sir F. Nicolson asked whether there was a conventional sign for showing the average depths of rivers. I do not know of one for this purpose; if the depth of a river were known and it was required on a map, it would be given by a figure. There are conventional signs in all countries for showing when streams or rivers are military obstacles, when they are fordable, and the limit of navigation distinguishing between ships and boats.

The CHAIRMAN: From the number of Officers who have taken part in the discussion, I think Captain Wilson need not have been afraid that his lecture would be uninteresting. On the contrary, it is a subject not only interesting, but also very important to all Officers in the present day. Therefore, I have great pleasure in returning thanks, on behalf of the meeting, to Captain Wilson for the lecture with which he has favoured us.

Evening Meeting.

Monday, May 6th, 1872.

Captain Jasper H. SELWYN, R.N., in the Chair.

NAMES of MEMBERS who joined the Institution between the 30th April and 6th May, 1872.

ANNUAL.

Batten, John M., Capt., 8th or King's Regt.
Erskine, George, Colonel, late Mil. Train.
Lewis, J. F., Lieut., R.E.
Yates, H. Peel, Colonel, R.A.
Balfour, Geo. M., Captain, R.N.
Farr, William, Lieut., R.N.

"THE RULE OF THE ROAD AT SEA, OR THE STEERING AND SAILING RULES."

By W. Stirling Lacon, Esq.

Mr. Chairman and Gentlemen,—During the last eighteen years that I have had the honour of taking an active part in the affairs of this Institution, I have always impressed upon every person desirous of bringing anything before the public in this theatre, the necessity of putting what he is going to say into writing, in order that he may condense his matter into the very smallest compass. But although I have given that advice to others, I find it is impossible for me to do the same myself, not so much because it is a technical subject, as that I am obliged to make use of little models, and therefore I could not work them and read any notes or written lecture at the same time. I am, therefore, going to trust entirely to experiment, that is, to trust throughout to my own memory; and if I should at any time fail, or break down, if you would kindly wait, and give me encouragement —having truth as my guide—I have no doubt whatever that I shall arrive at a satisfactory issue. It has been the custom also in this Institution for a lecturer to deliver his lecture first of all, and then for persons to put any questions to him during the discussion. Perhaps during the time that my models are on the table, it would be more advantageous if gentlemen would put any questions to me where I do not sufficiently explain myself. It would save time, because, probably, if we were to leave it to the end of the lecture, we would not be able to recur to the same position.

Gentlemen, I desire to point out to you that this subject was brought

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Vol. 16.

Diagram Nº 1.

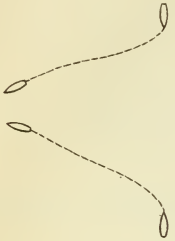
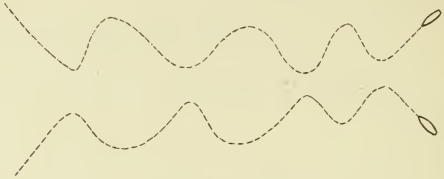


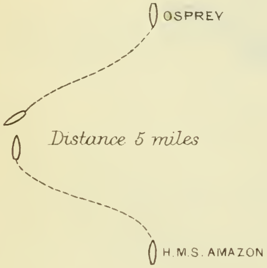
Diagram left at the Admiralty.

Diagram Nº 2.



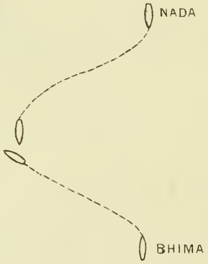
Course coming over from Antwerp.

Diagram Nº 3.



Both sunk 11 lives lost.

Diagram Nº 4



Bhima sunk 79 lives lost

Diagram Nº 5

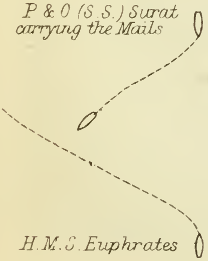
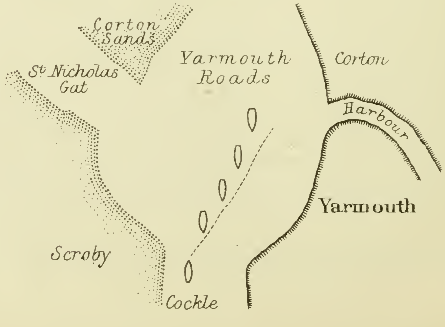


Diagram Nº 6.

28 large Steamers which had been lying at anchor followed each other in succession.



J. Jobbins

before this Institution six years ago. Two gentlemen, Captains Heathcote and Curme, came here and read papers on the questions of "Collisions at Sea," and "the Rule of the Road at Sea." The Institution devoted a number of its Journal to those subjects, and also to the question of the "loss of life at sea;" Mr. Holland, the member for Evesham (who is now out of Parliament), has brought it six times before the House of Commons; and Sir John Hay, the Chairman of the Council, is about to bring it to-morrow night for the third time, before Parliament. It may be asked, what have I to do with it? As a boy I was a sailor, and for 40 years I had not been at sea, and I had really forgotten all about these matters; but when this question was raised in this Institution, I will read to you what took place—I quote from the Journal of the Institution:—"It was after the discussion upon "Captain Curme's paper, on Monday evening last, that I went home "and pondered deeply upon what I had heard, and it was that night "from 12 to 3 a.m. that I lay awake during the very time that the "'Osprey' and 'Amazon' were sinking, and the next morning I "carried to the Admiralty a diagram, of which Diagram No. 1 is "a copy. I said then (24 hours before we received intelligence of "the collision) that vessels meeting in that position would in all "probability come to grief. This diagram, illustrating what actually "took place in the case of the 'Amazon' and 'Osprey,' was exhibited "to members in the library of the House of Commons during that "session of Parliament (1867)."

Many other circumstances have occurred, and have so acted upon my mind, that I have felt that I was called upon to press this subject upon public attention, and that it was a sort of mission which was given to me to carry forward. Shortly after this, I wrote the following letter to the Admiralty:—"Most earnestly would I press upon their "Lordships' consideration the following cases of collision, the consequence of the existing law and that which preceded it:—

"The 'Erin' and the 'Pasha,' in the Straits of Malacca.

"The 'Black Prince' and the 'Araxes,' off the Coast of Spain.

"Her Majesty's ship 'Amazon,' and the 'Osprey,' off the Lizard.

"The 'Mary Nixon' and schooner (name unknown), in the Channel.

"The 'Bruiser' and the 'Haswell,' off Aldborough.

"The 'Cobden' and the 'East Cornwall,' off Orfordness.

"The 'Bhima' and the 'Nada,' in the Red Sea.

"The 'Agra' and the 'Elizabeth Jenkins,' off the Ower's Light, "&c., &c."

After this I wrote a whole volume upon the subject in the public journals, and then I thought that I had done enough, and that I required a little recreation, and that the British public required a little recreation also. I decided, therefore, that I would go abroad, and I went to Norway. Now I ask you to follow me, because this is an international question, and the lives of foreigners are dependent upon it as well as those of our own people. After driving a thousand miles and parting with my friends, on my return to Christiania I found myself alone in a foreign country without language and without introduction.

But that very night I met the English Consul and the Norwegian Admiral. I spoke to the latter, and he asked me to come to the Admiralty to him the next day. I went, and I explained "the rule of the road" to him for an hour and a-half. He seemed very much impressed with what I said. He told me that Sweden and Norway were under the same Crown, and that they had independent legislatures, but that they acted in unison. He said, "Are you going to Stockholm? if so, I will give you letters of introduction." He did, and presently I came to Stockholm. At Stockholm they were prepared to receive me, and at the Admiralty at Stockholm six Officers were appointed to meet me. We went into this subject for two hours and forty minutes. I explained to them, as I explained to other Admiralties when I came to them, that I was a private individual without any authority whatever; merely desirous of eliciting truth, and that I was not in a position in any way to ask their opinion or to compromise them with their own Governments. When I got back to London, I received a letter from the Admiralty at Stockholm, saying that Sweden must follow England in "the rule of the road at sea," and thanking me for my noble efforts. That was very strong language to make use of to a total stranger, who had never seen these men but once. They called upon me the next morning at my hotel with a Danish Officer, and with letters of introduction to Copenhagen. In the course of time I came to Copenhagen, and there eight Officers were appointed to meet me. They sat round a table all in uniform, and the same thing took place as at Stockholm.

I then came to Hamburgh, and I wish to direct your attention to what took place. I asked the landlord of my hotel if he could bring me into contact with any gentleman who could forward the object I had in view. It so happened that he sent me to a gentleman who turned out to be one of the Senators of Hamburgh. By his instrumentality we got together the same evening eight competent men, masters of ships, and others, who met at seven o'clock. I went into the question the same as at Copenhagen and Stockholm for about two hours and a-half, and nothing could exceed the enthusiasm of these gentlemen. After our discussion was over, they told me a reporter was present, and that what had taken place should be reported in the newspapers, and that a copy with a translation should be sent to me in London. On my arrival in London in about ten days, it was quite evident that the Hamburghers had in the meantime communicated with England, for instead of receiving what I expected, I received a letter signed by all the gentlemen who were at the meeting, repudiating everything, and charging me with having come among them, and knowingly told them deliberate falsehoods. Few Englishmen would quietly have put up with this, and would have answered them probably in not very courteous language, but I was carrying forward a great question, and I am proud to read to you my reply, which is published by Parliament, for gentlemen, I did not allow my temper to interfere in any way with the object I had in view. "I received the letter which has been addressed to me from Hamburgh. But previous to this I had made a report of what had taken place in the various cities on the Continent. But I will take care that a copy of your letter shall be appended to the report, and that a copy shall also be forwarded to the various cities named. It is a question of human life, and I have no interest whatever in the matter; but Hamburgh may rest assured that into whatever hands this question may fall, and by whomsoever it may be dealt with, it will be in a spirit of gentlemanly feeling, generosity, and forbearance, antagonistic to the letter which has been addressed to me from Hamburgh." Gentlemen, has there been anything underhand here? It is not for me to say that. But shortly after this, the correspondence of the Board of Trade with Hamburgh was moved for in the House of Commons, and something else was laid upon the table. I repeat it. The correspondence of our Board of Trade with Hamburgh was moved for in the House of Commons, it was ordered, and something else was laid upon the table.

After this I came to the Hague, and got an introduction to the Member for the Hague, who, it turned out, had commanded a frigate in Japan. I was with him an hour, and he gave me a letter to the Admiralty at the Hague, telling me, "When you get back to London, "send me all the particulars, and I myself will bring the question before "the States General." I then came to Brussels, still with no introduction, but with truth as my guide. I called at the Foreign Office (at Brussels they have no Admiralty) and stated my case in a very few words. They said, "Will you call again to-morrow morning." I called the next morning and was told, "I am desired by the Minister "to inform you that he will immediately telegraph down to Ostend to "assemble all the Captains in the port, and when you get to your "hotel a letter shall be sent to you, accrediting you to go down on the "part of the Government." In consequence of this I went down to Ostend. At an assemblage of all the Captains in the port we went into this case thoroughly, and at the end of our discussion, the Captain-Superintendent rose, and, addressing me said, "Sir, we are unani- "mously in favour of your propositions, and we think that they ought "to be immediately translated into every foreign language." I went on to Paris and presented myself at the *Ministère de la Marine*. But France was, with England, the author of the existing rules; and, finding that there was reluctance to entertain the question, to use the words of Tennyson in his Northern Farmer, "I just coom'd away." I have received a communication from Washington to say "You have sent "quite enough to Washington to enable the people here to judge of "the merits of the case." And I have also received the thanks of the Minister of Marine at Rio, through their Minister in London.

Having said all this in order to show you the importance of this inquiry, I will now point out to you what was the position of this question when it was first brought under the notice of this Institution. This is a pamphlet "On the Rule of the Road for Steamers," which was issued at that time by the Association for the Protection of Commercial Interests as respects wrecked and damaged property (Lloyd's). There are three diagrams, and explanatory letter press, with A, B, C, and D, with one dot, two dots, and three dots. I will leave it upon the table for the inspection of any gentleman; but I question whether any senior wrangler at Cambridge could understand it.

Much about the same time there was issued from the Board of Trade, a paper containing a compass within a compass, and 480 questions. The Board of Trade have also issued 10,000 copies of "nursery rhymes," and a catechism. It is a new style of legislation in this country; and when I come to the end of my lecture I shall tell you what those "nursery rhymes" are. Now, how stands this question as regards Parliament? Parliament left it in this way ten years ago, that Her Majesty might on the joint recommendation of the Admiralty and the Board of Trade, alter and amend these laws. You will lay particular stress upon the word "joint," because anything that one does without the other is perfectly illegal. On the 22nd of February, 1867, the Admiralty wrote the following letter to the Board of Trade:—"My Lords Commissioners "of the Admiralty having received numerous letters on the subject of "the rules and regulations respecting lights to prevent collisions at "sea, I am commanded by their Lordships to acquaint you, that they "would propose, should the Lords of the Privy Council for Trade "concur, to appoint a naval Officer, and to request an elder brother of "the Trinity House to meet with him, and consider what mode, if "any, can be adopted to lessen the danger of collisions, and whether "any change is expedient; and my Lords would be glad if a gentle-"man from the Board of Trade could join in the consideration of the "subject." On the 14th of June the Admiralty again wrote to the Board of Trade:—"Having laid before my Lords Commissioners of "the Admiralty your letter of the 3rd instant on the subject of the "International Steering and Sailing Rules, I am commanded by their "Lordships to acquaint you, for the information of the Lords of the "Committee of Privy Council for Trade, that my Lords were, and are "still prepared to appoint an Officer to aid in the consideration of the "subject, but that as the Lords of the Committee of Privy Council "have expressed such strong objections to re-open the case, my Lords "do not intend to take any further steps in the matter."

The Admiralty having retired from the case altogether, and the co-operation which ought to exist between the two departments having ceased, surely the time had arrived for the interference of Parliament. Mr. Holland has six times brought the question before the House of Commons, and Sir John Hay twice.

Mr. Holland, writing to the President of the Board of Trade, March 2nd, 1869, says:—

"I must be allowed an expression of regret at your refusal to take "into consideration 'the rule of the road at sea,' as brought last week "before the House of Commons by Sir John Hay. Your reply to that "gallant gentleman cannot be looked upon as satisfactory by any one "who has investigated the present working of the rules. Although, "like yourself, no sailor, I have been so struck with the frequency of "collisions at sea, that I determined upon ascertaining what there was "in the regulations admitting of their constant occurrence, and I found "that the rules which were enacted in 1862 are framed contrary to the "custom of the sea, and the practice of seamen; not with regard to

" steam-ships only, but the rule for sailing-ships, which had obtained " for centuries, was altered at the same date. Now had Sir John " Hay's request of an enquiry into the causes of collisions been ac- " ceded to, this would have been made evident.

" For the last two years and a-half I have paid much attention to " the subject of collisions at sea, and I have six times in the House of " Commons either moved for papers, or asked questions of Government " connected with these Rules of the Road, but on each occasion of my " doing so I have received either an evasive reply, or have had a " promise—which has never been fulfilled—of the papers being forth- " coming after communications (which were pending) had taken place " with France and other Governments.

" I now beg to call attention to the fact that the Rules of the Road " at Sea, common to other nations with ourselves, have been altered, " and amended, without communication with those nations (the Order " in Council of August 4th, 1868, is an instance of this), and that, " therefore, the grounds on which you declined the consideration of " Sir John Hay's suggestions surely are not tenable.

" From the single wish to frame regulations such as may prevent the " loss of life at sea to the fatal extent which at present prevails, I pray " you, Sir, to give the question of 'the Rule of the Road at Sea' your " best consideration."

Mr. Holland, being out of Parliament, the President of the Board of Trade, in answer to Sir John Hay, says, February 26th, 1869 :—

" With respect to the question which has been put by the hon. and " gallant gentleman, the member for Stamford, the House will hardly " expect that I, who am not a sailor (a laugh), should enter into " minute and technical points to which he has drawn attention. The " rules now in force are, I may add, very simple. They are such that " any person may learn them, as a child does a nursery rhyme, in a " very short period, and it is impossible that a man sober, in his senses, " and not panic stricken by the events of the moment, should not be " able to remember and apply them. They are taught to all masters " and mates of ships, who cannot obtain their certificates until they " thoroughly understand them."

What, I would ask, becomes of the great bulk of the maritime population who are not taught these rules, nor the nursery rhymes, nor their catechism, and know nothing whatever about them ?

Again, on April 25th, the President says :—

" From all the advice I am able to act upon, I think it would be " very disadvantageous to appoint a committee, and disturb in this " country, by inquiry, any question which all maritime countries at " least believe to be satisfactorily settled."

Yet, at this very time, the Board of Trade were in negotiation with the French Government, and the communications are very much in the style of the Association's pamphlet above mentioned.

On reading in the Parliamentary proceedings what has been addressed to the French Government, I feel positively ashamed for the honour of my own country. But I go further, and when I find this reply, " Cet article me paraît dangereux dans sa réponse ; il y a là une "appréciation qui va bien au delà du texte du réglement international," I say if a proposition has been made to any foreign Government which will bear such a construction, who made it?

Mr. BRASSEY, M.P.: May I ask what the proposition was?

Mr. LACON: I cannot tell; the above is the answer. But I will go further. It is impossible that an Order in Council can be issued without the concurrence of the Admiralty, because, if you recollect, I read to you that the *joint* concurrence of the Admiralty was necessary. But I am going to shew you presently that an Order in Council has been issued. How was it then issued without the concurrence of the Admiralty? I say that the concurrence of the Board was never obtained, that the question was never submitted to the Board.

We will now go back to the Privy Council, and I am going to show you what a dilemma we have been brought into. The Board of Trade applied to the Privy Council for an Order in Council, and the Privy Council write, 11th February, 1868,* "I have the honour to acquaint you, for "the information of the Board of Trade, that I have laid before the "Lord President of the Council and the Lords of the Judicial Com"mittee your letter of the 21st of January, enclosing certain memo"randa and diagrams, intended to explain to sea-faring men the rules "established by the Order in Council of the 9th of January, 1863, and "requesting to be informed whether their Lordships see any objection "to the official issue by the Admiralty and the Board of Trade of the "memoranda and diagrams in question, and I am directed by their "Lordships to give the following answer to this question:—

"It does not lie within the province of their Lordships to offer any "opinion on the merit of these memoranda and diagrams for nautical "purposes. They confine themselves therefore to the obvious remark, "that the promulgation by authority of these explanatory memoranda "and diagrams would naturally suggest the inference that the existing "rules, which have the force of law, are not sufficiently clear and ex"plicit, and that the diagrams by which those rules are accompanied "do not accomplish their object.

"In other words, the existing rules are condemned by the course "proposed to be taken; and in the eyes of the class of persons whose "duty it is to apply the sailing regulations the interpretation would be "apt to supersede the enactment.

"The opinion which the Lords of the Judicial Committee have "formed on this subject is, however, mainly based on their Lordships' "experience as the High Court of Appeal for maritime causes; and it "is chiefly to the legal consequences of the proposed 'memoranda and "'diagrams' that their Lordships have addressed their attention.

"The direct legal consequences would be a nullity, inasmuch as it is "admitted that these 'memoranda and diagrams' have no legal autho"rity whatever; but the indirect consequences would, their Lordships "apprehend, prove exceedingly inconvenient. It is proposed to place "in the hands of sea-faring men two documents, the one purporting to "explain the other. If they are absolutely identical in form, it is

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* See Parl. Pro., 1869, 115, No. 33.

" difficult to see what is gained by this addition. If they are found to " vary, however minutely in expression or purport, the commentary, " which is of no authority, would, in practice by seamen, supersede " the text, which is the law. It would be difficult to make a seaman " understand the principle of law by which he would be absolutely " precluded from pleading these 'memoranda and diagrams' in a " collision suit, whilst he would be held liable by the Court for the " slightest deviation from the rules themselves.

" Their Lordships must observe that it appears to them dangerous " in principle to attempt to give in an official paper that interpretation of the existing law which appertains to courts of justice only; " and no one can tell until a given case arises, and is argued, whether " there is perfect harmony between the letter of the rules and these " 'memoranda and diagrams,' or whether the latter may not contain " directions and explanations tending to mislead the seaman.

" Moreover, it must be remembered that the concurrence of all the " maritime Powers has been obtained to the existing rules, which have " become therefore at this time the general law of the sea. No such " concurrence has been obtained for these 'memoranda and diagrams.' " They may or may not be accepted and adopted by foreign nations. " But if Great Britain were to set the example of issuing an official " paper to explain and illustrate her own rules, there is no reason " that each of the maritime powers should not do the same thing " in other forms, and instead of the uniformity of regulation which " has been happily established, the question might relapse into confusion.

" On these grounds the Lords of the Judicial Committee think that " the official publication of these documents is open to serious objections, more especially with a view to the application of that legal " liability which it is the duty of courts of justice to enforce in cases " of collision at sea.

" If the existing rules are imperfect they ought, in their Lordships' " judgment, to be rendered more complete by the addition of further " rules emanating from the same power as the rules themselves and " clothed with the authority of the law. But the interpretation of the " rules must, according to all sound legal principles, rest with courts " of justice alone, and cannot safely be assumed or anticipated by any " administrative department of Her Majesty's Government."

Notwithstanding this letter of the Privy Council, notwithstanding the action of the Admiralty, the Order in Council of August the 4th, 1868, was issued explaining the rules, and altering and overriding the interpretation of them, as laid down by the Admiralty Courts both in England and Ireland. This Order in Council has not received the concurrence of the Foreign Powers, parties to the rules of 1863; and on March 9th, 1869, the Board of Trade sent the following instructions to the Foreign Office:—" In short, it is for each country to act in " such a manner as her laws and method of procedure may require, " in order to promulgate and give effect to the explanation of the " rule."

The CHAIRMAN: Mr. Lacon, I must ask you to allow me to take the sense of the meeting, because these statements involve the conduct of two departments of the State. Technicalities are what we discuss here.

Mr. Lacon: I am coming to the technicalities, because I have nearly finished on this point. On the 22nd of December last the *Shipping Gazette* says, "That the learned Judge of the Admiralty Court has "adhered to the principles enunciated by Dr. Lushington, and has not "been guided by the Order in Council," and asks "Whether the Law "Officers of the Crown should not be instructed to give their opinion "as to the power of the Government to interpret a statute by such a "declaration as that of the Order in Council referred to."

Now, as the Chairman has suggested to me, we will go into the technicalities of the subject; and first of all I will ask you to dismiss from your minds entirely the question of steam, because a sailing vessel and a steam vessel are two wholly different things. We must first entertain the question of sailing ships, and ask what was the condition of things previous to those rules being issued.

For centuries there had been no written law. The custom and practice of the sea had obtained ever since we were a maritime country —and this custom and practice obtain to this moment, notwithstanding the existence of the rules; eight-tenths of the sea-faring population never having heard of the rules at all, and the remainder probably imperfectly understanding them. Now, what is Sir John Hay proposing? He says, If you must have a rule, make your rule and your custom the same; put your custom and practice into words. When I say that so large a proportion as eight-tenths of the sea-faring population never heard of these rules, is it to be wondered at, when the Navy know nothing about them? Let me quote from the letter of a gallant Admiral in the *Times* of November 27th, 1866. Since I have been connected with this subject, I have never taken any notice of an anonymous writer; but Admiral Ryder, like a British Admiral, always carries his flag at his mast head, and is never ashamed of what he is doing. He says: "I have good reason for believing that the altera- "tion which was made by an Order in Council in the sea rule of the "road in 1863 is not so generally understood by the young Officers of "the Royal Navy and the merchant service as it should be. It is "urgently necessary that the Officers of the watches—who in the "smaller men-of-war may be midshipmen, and sometimes warrant "Officers, should know the existing Rules of the Road by heart, so as "to be able to apply them on the shortest notice. I beg to suggest to "the Officers who have, or who are likely to have, the charge of the "watches at sea in any of Her Majesty's ships, that if they cannot "obtain a copy of the Addenda to the Admiralty Instructions (which "Addenda are out of print), and if they cannot obtain a copy of "the Regulations for Preventing Collisions at Sea (which have been "issued by the Board of Trade, and are supplied to men-of-war on "demand), they would do well to cut this letter out of a copy of the "*Times* and keep that portion of it which contains the extract from "the existing regulations in their pocket-books for frequent reference; "otherwise, the same fate may await the vessels under their charge "which overtook Her Majesty's ship 'Amazon,' and the steamer "'Osprey' in the early part of this year."

Now, I was present at the Court-Martial after the collision between the "Amazon" and the "Osprey;" and, standing outside the door, surrounded by the Captain, Officers, and men of the "Amazon," they one and all declared that they had never heard of these regulations, and they supposed if they had been sent on board they had been relegated to the gunner's store. Somehow this came to the ears of the then First Lord of the Admiralty (Sir John Pakington), and he wrote to me to verify it—which I did. Here then was a case of a merchant ship acting under the rules, and Her Majesty's ship acting under no rules at all. Both were sunk, and, besides eleven lives, the country suffered the loss of a fine new ship, fully equipped, besides paying for the "Osprey" to the tune of about £35,000.

Before entering into details as regards the existing rules, and what Sir John Hay proposes as amendments to them, let me call your attention to four points, applying both to the rules for sailing vessels and also to those for steamers. You will notice in both cases the rules begin with the expression—"If two ships." This is utterly wrong; for a man is not only expected to command his own ship, but to be influenced by, if he cannot control, another. Through fog or thick weather, or his eyesight from any cause not being over clear, he cannot tell whether it is green to green, or green to red, and he goes on approaching his object in order to find out!! He finds this out when it is too late, and then probably puts his helm hard-a-port, according to "Cocker."

Sir John Hay says, both as regards sailing ships and steamers, that every vessel shall be a law to herself and mind her own business, and that a steamer having anything on her port or starboard side shall go away from it.

Besides this, there are in both cases "two rules," and it is impossible to say where one begins and the other ends; one vessel may therefore be acting under one rule, and the other vessel under the other. Again, there is the remarkable expression, "If there is risk of collision." What is risk of collision, and how are two men in different ships to know, in order to act upon, what is the risk of collision; because if one thinks that there is risk of collision, he acts according to the rules, whereas the other, if he thinks there is no risk of collision may be acting regardless of them.

The other point is the indefiniteness of language of these rules. It is not a question as to what was the intention of the framers of these rules in using the expression "nearly end-on;" but the law as it now stands by the interpretation and decisions of the law courts is—that a ship having another two points and a half on her starboard side is bound to port and cross the other's path. And the Right Honourable the President of the Board of Trade says, "That it would be very "disadvantageous to appoint a Committee, and disturb in this country "by inquiry any question which all maritime nations at least believe to "be satisfactorily settled."

I will now read to you the custom and practice of the sea, which

Sir John Hay proposes to put into words, and you can compare it presently with the existing law, and say which is the more simple, or likely to be understood by our seafaring population. You will notice that in Sir John Hay's rule for sailing ships, no mention is made of the helm, and in the rules no mention is made of the word "tack," sailors knowing and understanding nothing else.

"A sailing ship on the port tack shall give way to a sailing ship on " the starboard tack; a sailing ship with the wind free shall give way " to a sailing ship close hauled. Where two sailing ships, each with the " wind free, meet on opposite courses, the ship which has the wind on " her port side shall pass to leeward of the ship with the wind on her " starboard side."

Now for the rules.

" If two sailing ships are meeting end-on, or nearly end-on, so as to " involve risk of collision, the helms of both shall be put to port, so " that each may pass on the port side of the other.

" When two sailing ships are crossing so as to involve risk of collision, then, if they have the wind on different sides, the ship with the " wind on the port side shall keep out of the way of the ship with the " wind on the starboard side; except in the case in which the ship with " the wind on the port side is close hauled and the other ship free, in " which case the latter ship shall keep out of the way; but if they have " the wind on the same side, or if one of them has the wind aft, the " ship which is to windward shall keep out of the way of the ship which " is to leeward."

Then, as if to throw doubts upon the minds of men at the critical moment of action—

" In obeying and construing these rules, due regard must be had " to all dangers of navigation; and due regard must also be had " to any special circumstances which may exist in any particular " case, rendering a departure from the above rules necessary in order to " avoid immediate danger.

" Nothing in these rules shall exonerate any ship, or the owner, or " master, or crew thereof, from the consequences of any neglect to carry " lights or signals, or of any neglect to keep a proper look-out, or of " the neglect of any precaution which may be required by the ordinary " practice of seamen, or by the special circumstances of the case."

Then, to simplify matters, the Order in Council which has not yet been concurred in by other powers, is as follows:—

" The said two Articles, numbered 11 and 13 respectively, only apply " to cases where ships are meeting end-on, or nearly end-on, *in such a* " *manner as to involve risk of collision.* They consequently do not apply " to two ships which must, if both keep on their respective courses, " pass clear of each other.

" The only cases in which the said two Articles apply are when each " of the two ships is end-on, or nearly end-on to the other; in other " words, to cases in which *by day* each ship sees the masts of the other " in a line, or nearly in a line with her own; and *by night* to cases in " which each ship is in such a position as to see both the side lights " of the other.

"The said two Articles do not apply *by day* to cases in which a ship "sees another *ahead* crossing her own course; or *by night* to cases where "the red light of one ship is opposed to the red light of the other; or "where the green light of one ship is opposed to the green light of the "other; or where a red light without a green light, or a green light "without a red light, is seen ahead; or where both green and red lights "are seen anywhere but ahead."

You may laugh; but that is the law.

We will now pass on to steamships, the rules being the same, with the exception of the two following, which must be substituted for the two first rules quoted above:—

"If two ships under steam are meeting end-on, or nearly end-on, so "as to involve risk of collision, the helms of both shall be put to port, "so that each may pass on the port side of the other.

"If two ships under steam are crossing, so as to involve risk of colli-"sion, the ship which has the other on her own starboard side shall "keep out of the way of the other."

Sir John Hay, acting in the spirit, although he is no longer able to follow in the letter of the custom and practice of the sea, has put forward the following simple and concise rule:—

"A steamship having another
  "end-on shall port,
  "on her port side shall port,
  "on her starboard side shall starboard, and *stop*."

I beg of you to keep your eyes upon this rule during the various illustrations which I am about to put before you, because, if as a safe rule or guide, it should fail in any one case, I am prepared to abandon it. It will be noticed that if a vessel has another on her port side, she may go on in safety, because, should the other be crossing her path, or presenting her starboard side, or green light, she (the latter) would be bound to turn away and *stop*. For the same reason, if a vessel has another on her starboard side, she should turn her head away, and be prepared to stop, because if the other is crossing her path, she must be presenting her port side, and red light, and is entitled to pass on.

To port the helm and go to the right is the rule, and starboard the helm and go to the left the exception, the one involving safety, and the other danger and caution.

Sir John Hay says the helm, and not what you see, is the first consideration, and that were such a law to be passed, any vessel hereafter striking another with her stem ought to be condemned.

Diagram No. 2 represents what happened to myself, coming over from Antwerp in a dark night. We saw a steamship on our port side, we came together, and we sheered off. Presently we came together a second time, and we sheered off. Then we came together a third time, and sheered off again. Once more we tried it on, and sheered off again, and I do not know what became of us afterwards, for I went to bed; but Sir John Hay says that the steamship having another on her starboard side, shall starboard and *stop*.

Diagram No. 3 represents the collision between Her Majesty's ship

"Amazon" and the "Osprey." The sea was perfectly smooth, with a slight breeze from the north-west. These vessels saw each other five miles off, and as the "Amazon's" fore and aft sails were lifting, and she was going out to the West Indies, the officer of the watch (Sub-Lieutenant Loveridge) starboarded her helm, the look out man shortly after reporting a light two points on the starboard bow; and I would ask any gentleman present if a ship was not entitled to do this—whether the seas would be navigable? I will tell you what afterwards happened; but the following is the decision of the Court-Martial:—"That the collision was occasioned by a grave error in judgment on the "part of Sub-Lieutenant Loveridge, the officer of the watch, in putting "the helm of the 'Amazon' to starboard instead of to port when first "sighting the light of the 'Osprey' (the two vessels being then five "miles apart) in contravention of the regulations for preventing colli-"sions at sea." Sub-Lieutenant Loveridge was cashiered, but recommended to mercy. The finding and sentence were ordered to be read on board all Her Majesty's ships in commission. Now what did the "Osprey" do? She is acting under the rules, and she sees the "Amazon" end-on or nearly end-on, and ports her helm, (these vessels are very fast,) and presently she is steering, not by her compass, but by the light of the other vessel (the "Amazon"), and before the collision, was actually almost at a right angle to her course. They soon come into the position indicated in Diagrams 1 and 3, and Sir John Hay says, "that a steamship having another on her starboard side shall starboard and stop," but the Sub-Lieutenant of the "Amazon," (who was cashiered for starboarding,) thought he could go under the stern of the "Osprey" and put the "Amazon's" helm hard-a-port, but he couldn't; the "Amazon" struck the "Osprey" on her port quarter, wrenched off her own prow, which had been specially constructed for ramming, and both were sunk. Mercifully the water was very smooth, or hundreds would have been drowned, instead only of eleven. The poor captain of the "Osprey" told me that his children, who about an hour before were dancing upon the deck, were all drowned. I shook hands with him, and pledged myself that I would never leave the subject until I had brought it before the country. Yesterday an honorable Member met me, and asked if I was well up in the statistics of the "loss of life and property," but I told him that I wanted no statistics, for if one life was lost through any defect in these laws, Parliament was bound to amend them.

I have told you that the "Osprey" was acting under Rule 13, the "Amazon" was acting under no rules at all, because they had never heard of them. If they were sent on board they were sent—(Captain Colomb: They were in the Addenda at the time on board the ship.)—I am only giving you what I was called upon to verify, and I did verify it. The Officers and men told me they had never heard of the rules.

We will now take another case, the "Bhima" and the "Nada" (Diagram No. 4). The "Nada" was coming up the Red Sea, and the "Bhima" was going down. The "Bhima" had the "Nada" on her starboard side, and when they were within 600 yards of each other, she put her helm hard-a-starboard. The "Nada" saw the "Bhima" "end-on or nearly end-on," and she ported. In the case of the "Amazon" and the "Osprey," the "Amazon" put her helm hard-a-port; but now the "Nada," put her helm hard-a-starboard, struck the "Bhima," and sunk her, simply for want of Sir John Hay's rule, "that a vessel having another on her starboard side, shall starboard and stop, and let the other vessel pass." This terrible calamity occurred at half-past seven in the evening on a fine night. The passengers of the "Bhima" had been dancing on the deck just half an hour before; and by that unfortunate collision seventy-nine people were drowned. I say it is a justification for me or for anybody else to force this matter upon the attention of the Legislature of the country.

I will take another case, Diagram No. 5. H.M.S. "Euphrates" going up the Red Sea saw the "Surat" coming down. The "Surat" was a Peninsular and Oriental steamer, carrying the mails. The "Euphrates" had the "Surat" on her starboard side; and the "Surat," seeing the "Euphrates" "end-on, or nearly end-on," ported her helm. But the Captain of this ship was a judicious man. He would not drown his passengers or lose his ship. He *stopped*, and let the "Euphrates" go past, which she did at full speed. He sent in to the Peninsular and Oriental Company a report of what the "Euphrates" had done, and the Captain of H.M.S. "Euphrates" made an apology to the Company. The "Surat" was on the right tack, and had the other on her port side, and was entitled to cross the other vessel's path. Instead of that, the "Euphrates" went across her path at full speed. We want a law (that of Sir John Hay) "that if a vessel has another on her starboard side, she shall starboard and stop, and let the other vessel pass."

Further, to show the operations of these laws, this is what takes place in my own country. Diagram No. 6 represents a rough plan of Yarmouth Roads. A vessel is coming in at the Cockle. It is no supposititious case. I have myself seen after a northerly gale, twenty-eight large steamers following each other in succession. This vessel wants to get out at St. Nicholas Gat. She sees one vessel, and if she acts according to law, she must port, she must port to the second, and she must port to the third, and so on in succession. But according to Sir John Hay's rule, she may go anywhere she likes. If she is under starboard helm, she must be prepared to stop, and let another vessel pass, which is under port helm.

Admiral Halsted: How do you apply the terms port and starboard helm?

Captain Colomb: Do you mean that she has got her helm over?

Mr. Lacon: I should have said, "having another on her port side or on her starboard side." In making a law that a vessel shall port, if she has another on her port side, it does not follow that she should move her helm, unless there is necessity to do so.

In the same way, if you see another vessel's green light on your starboard side, although Sir John Hay says, "a steam-ship having "another on her starboard side, shall starboard and stop," it cannot in this case be necessary to stop, but if you are not sure, if it is foggy, and you cannot make out what you have on your starboard side, surely it is better to stop than have a collision.

Admiral HALSTED: When a vessel is on my starboard side, is that the same as having my helm a starboard?

Mr. LACON: Certainly not. But if you have got another on your starboard side, you shall starboard and stop if you are not certain of what you are doing.

Admiral HALSTED: Very good; that makes it simpler.

Mr. LACON: Because every case of collision occurs by one vessel running into another with her stem. But according to this plan of Sir John Hay, if two vessels do collide, they would collide broadside to broadside; and we are perfectly agreed upon this, that if in future any vessel should strike another with her stem, she ought to be condemned.

Mr. THOMAS GRAY, Assistant Secretary of the Board of Trade: I should like to ask one question. I do not know whether Mr. Lacon is going to give us time to discuss anything that he has said. I am afraid the time is getting short.

Mr. LACON: I will finish, then, because the other points, though really points of very great importance, have been discussed with the Cinque Port pilots.

I said I would lay before you the "nursery rhymes" which have been mentioned in the House of Commons by the President of the Board of Trade. 10,000 copies have been issued by the Board of Trade, and they have been translated into Danish, German, and Italian, as the "British verses." I do not understand Danish or German, but I do understand Italian, and of all the extraordinary poetry that ever I read in my life, when it comes to be Italian, I think I never saw anything like it. Here is a copy of these rhymes, which have been put into the hands of the illiterate population of the Norwegian and Swedish coasts.

Mr. BRASSEY, M.P: Is that done by order of the Board of Trade of England, or by the order of some other authority?

Mr. LACON: I cannot say whether they were ordered by the Board of Trade of England, but they were issued from the Board of Trade, and sent to all the outports.

Mr. BRASSEY: If copied into a foreign language by naval authority abroad, it would seem to imply that that authority approved of them.

Mr. LACON: I am glad it is a member of the Legislature who asks that question. It is impossible for me to trace how it has been done; but I will ask you to allow me to read them.

"Meeting steamers do not dread,
When you see three lights ahead,
Port your helm and show your red!
Green to green, and red to red,
Perfect safety—go ahead!

"If to starboard red appear,
'Tis your duty to keep clear;
Act as judgment says is proper
Port, or starboard, back, or stop her!

"But when upon your port is seen,
A steamer's starboard light of green,
There's not so much for you to do,
The green light must keep clear of you.

"Both in safety and in doubt,
Always keep a good look-out,
In danger, with no room to turn,
Ease her! stop her! turn astern?"

Now *Punch*, who is a very clever fellow, and says a good many things very much to the purpose, says with reference to this:—

"Meeting steamers do not dread,
When you see three lights ahead;
Port your helm and go to bed!
And if you're smashed, what can be said?"

And, in searching for information to lay before you, I copied the following from a lecture given by Mr. Napier, F.R.S. He says:—

"Meeting steamers I'll not dread:
When I see three lights ahead
I'll port my helm and show my red,
And if I'm smashed, what can be said?

"Green to green—so it's said—
Is perfect safety—go ahead!
But if the lubber port, I say
A collision's likely—Thomas Gray."

I have exhausted my time by a long way. I should like to have gone into points, such as "lights astern" and "danger lights," which are very important, and which have been approved by the Cinque Port Pilots and the French Government. But the result of all that Sir John Hay is going to propose to-morrow night is—and you will see the importance of it as bearing upon the illiterate sea-faring population of the country who have to work them—that these rules are to be reduced from 749 words to 144.

A VISITOR: As a sailor, I must say there never were such barbarous rules made in any intelligent country.

Admiral HALSTED said he sympathised strongly with the benevolent objects of the lecturer, and pronounced the rules as barbarous and defective.

Mr. THOMAS GRAY: Mr. Chairman and Gentlemen,—I have listened with very much pleasure to Mr. Lacon's diverting lecture. I think he does owe me something in having been able to use my verses to lighten up what otherwise would have been a very dull affair. But I take strong exception to the manner in which Mr. Lacon has treated this subject throughout (No, no). But I do. And I have a right. Mr. Lacon has read extracts from Parliamentary papers, but he has not read the whole of the paragraphs bearing upon the points. Mr. Lacon has told you in effect that the Board of Trade sent this Order in Council to the Council Office without the consent of the Admiralty. Now what is the fact? (Mr. LACON: I said that "the concurrence of the Board was never obtained, that the question was never submitted to the Board.") If the notes are correctly taken, I think you will find that in substance what I say is right. At any rate, let me finish what I was about to read :—" Admiralty, 14th July, 1868. Sir,—Having laid before my Lords Commissioners of the Admiralty your letter of the 6th inst., requesting their statutory concurrence in the Order in Council proposed to be issued on the subject of the Rules of the Road at Sea, I am commanded by their Lordships to express to you their concurrence in the same. I am, &c. Signed H. G. Romaine. To the Assistant Secretary Marine Department, Board of Trade." The Board of Trade are required by Statute to obtain the concurrence of the Admiralty before they can recommend Her Majesty by Order in Council to move in the matter. And the Board of Trade did obtain that statutory concurrence, and that statutory concurrence is in that letter which was in Mr. Lacon's hands, and he never mentioned it. I think it right to point this out, because otherwise you would have assumed that the Board of Trade had gone against the advice and against the wishes of the Admiralty. The truth is, as every one can see for himself, that the Board of Trade and the Admiralty and the Trinity House are now thoroughly at one on the subject. I am not here to defend the Board of Trade. It is not often that in this Institution opportunities are taken to attack the public departments. The Board of Trade can take care of itself. I am merely about to point out to you one or two other omissions on Mr. Lacon's part. Mr. Lacon referred to a French reply which is in the papers. He did not tell you that that French reply was not an objection to the Rule of the Road at all. It was an objection to an answer in what was called a catechism, and he did not tell you further that, after the French had objected to that one point of the catechism, the catechism was amended and sent back to them, and then they approved of it, and do approve of it at the present moment. It is too much the fashion of many gentlemen to speak of the Rule of the Road at Sea as being made by one department of the State. Whereas the fact really is, that the Rule of the Road at Sea was not made by one department or made by one State, but has been made by competent departments in every maritime State in the world. And those maritime States agree to maintain it as it is. It is useless for me to follow Mr. Lacon through the quotations from his papers, or through the cases he has given you. I am very glad to see that he has discussed these rules which are technical, in an Institution like this, where technical points can be discussed, and I hope he will give us another night on which we can really go into the technical part of it, taking to-night as a mere preamble. If we do so, I think, although I am not a sailor, I can show you that his rules are wrong mathematically, and that they must inevitably lead to collisions instead of preventing them.

A VISITOR: Pardon me, if you are not a sailor, and many gentlemen who are sailors who have left the room, have expressed themselves strongly pleased, why do you make that observation?

The CHAIRMAN: The discussion must not degenerate into a conversation. We shall be delighted to listen to you after this gentleman has done.

Mr. GRAY: I must claim the protection of the Chair. The fact of my not being a sailor will give to the gentleman who has interrupted me, if he is a sailor, the power of refuting more easily what I may say.

Sir GEORGE HODGKINSON: I wish to make one or two remarks. I think Mr. Lacon is entitled to very great praise, but I am sure the approval of his own mind will be his best reward. I believe there can be no subject upon which a man can better bestow his talents than the subject which Mr. Lacon has taken in hand for some years past. I had the pleasure some few years ago of seeing Mr. Lacon on the subject. We have not met since that period. Mr. Lacon knows that I have taken a deep interest in this matter. For two reasons, I think Mr. Lacon is entitled to a great debt of gratitude, on the score of humanity, as well as that it is a matter of policy for the country. The loss of property at sea belonging to this country is probably nearly £100,000,000 a-year. The loss of life I do not know, but it is very large. You see, therefore, it is not only a question of humanity, but it is a question of national importance. I do not say how much of that loss is caused by the want of a Rule of the Road, but the tendency of people now-a-days is to carelessness. And whatever can simplify the rules, or the instructions for men to follow, would be a very great advantage. Many people think that we have too much legislation; and some think that we have not enough. I believe the majority would think that if there is to be any legislation on this subject, we ought to have still more. If the

Rule of the Road could be simplified in some way, it would be desirable, though many persons are of opinion that if sailors would act on the rules which previously existed, they would do much better than they do now. Certain I am that greater care would be taken, for Jack is careful of his own life; but he does not care so much for other people's property. That is, his tendency is to carelessness, and if you had to pay claims as we have had to pay, something like £100,000 in one year, chiefly through their carelessness, you would feel interested in the subject, and desire that something should be done to simplify the way in which people go on. We have in so many cases to deal with widows and orphans, that it makes the duty extremely onerous, and me extremely sensitive. Two years ago I addressed to Mr. Bright three recommendations, a Rule of the Road for rivers, the navigation of barges on the River Thames by steam, so as to make the highway practicable, because it is no longer what it used to be; and also the criminal punishment of mariners in cases of culpable negligence or carelessness, especially when loss of life has occurred. I suppose Mr. Bright would kindly take notice of anything I suggested, and a communication was made to the Conservators as to a Rule of the Road for rivers, and I believe they last year re-enacted the Rule of the Road with regard to the Thames. I could illustrate many cases where people have been going wrong without the slightest knowledge. There are two vessels that I instanced, the "Velocity" and the "Carbon," to show how little the rule is understood, and what a necessity there is for some positive rule. At the trial at common law, the jury found for the "Velocity." On the case being taken to the Admiralty Court, the decision was in favour of the "Carbon." On a motion for a new trial in the Court of Exchequer, the verdict of the jury was upheld. I said "Permit me now to acquaint you that "the Privy Council have reversed the decision of the Admiralty Court, having "decided in favour of the 'Velocity,' thus rendering decisions at the common law "totally at variance with that of the Court of Admiralty." Then the Board of Trade wrote to me, and asked me to furnish them with statistics upon which I based my statement, that the Rule of the Road was attended with loss of life and property. My reply to that was, to refer to the want of unanimity in the decisions of the cases of the "Velocity" and "Carbon." Now, with regard to criminal punishment, I quite admit that, in these days of progress, every man works to get money. As a steamship owner said to me, "If we stopped at every light we saw, we should never get to London," and owners would not like to see their men punished. But I do not see any reason why, if your coachman knocks a man down in the street, and is treated criminally for it, and if he is guilty of negligence, he is punished, the same law should not apply to seamen. We have a law, but common juries cannot be got to apply it. They will not use it. What we want is a public prosecutor, and until we get that I do not think much good will be done. The Government do not wish to appoint one. I do not allude to the reasons why they do not. But I think until somebody is appointed in the shape of a public prosecutor, you will find carelessness go ahead in the most painful way. After what I have said, you will not be surprised that I think the lecturer feels on this matter as a human being, as I do, which you may believe when I tell you that my pecuniary interests are against amending this state of things, because a great part of my occupation arises through the carelessness of sailors. I feel, however, that carelessness is so increasing with navigation that whatever degree of perfection you may attain by legislation, you will still have a vast deal of mischief going on.

Mr. Traill: I should crave your indulgence for two minutes, and I hope what I have got to say will have some weight. Having had some dozen years' experience afloat, and having the acquaintance of many able naval Officers, I am happy to be able to say in contradistinction to Mr. Lacon, that I do not know one naval Officer who does not know the Rule of the Road thoroughly. Having had very much intercourse with the mercantile marine of the world, and being daily and hourly in intercourse with Captains and Officers, I can only say this, that no people can wish for the Rule of the Road to be more perfect than they can; and I have heard them universally express their opinion that they should be sorry to see any such alterations as Mr. Lacon would wish, and they expressed themselves satisfied with the present Rule of the Road. That man must have a very mean comprehension who cannot understand it. As regards those nursery rhymes, I can only say that the superintendents of all the best Companies in this country have ordered from the printers some thousands of copies of them, and have distributed them gratuitously among their Officers, considering them one of the best aids to memory to guide them and keep them out of collisions.

Commander W. Dawson, R.N.: The gentleman who has just sat down said that he is not acquainted with any Officer who does not understand these rules. I am sorry that I have not the honour of that gentleman's acquaintance, or he would not be able to repeat that statement. I rise because I do not understand the present manifold Rules of the Road at Sea. I have heard a great many lectures on the subject, and I have read a great many pamphlets, and though I have heard another lecture this evening, I am free to say that I do not yet understand all the various applications of these manifold rules. My capacity is not perhaps very large, still I do not think it is below the ordinary run of our seaport population, and I really find these numerous rules exceedingly difficult to comprehend. I have no doubt that if I were to sit down and really try to study them, that I should be able to understand them as well as the differential calculus, or that if I had large experience of their use, I should be quite conversant with their practical application. But I mean to say that I cannot understand all their bearings off hand, and that they cannot be fully understood without that attentive consideration and close study which I do not think it should be necessary for seamen to give in order to comprehend a common every-day sea rule. I am extremely sorry that Mr. Lacon has thought it necessary to allude so much to the different public departments. I was very sorry indeed that some member checked Mr. Gray in the answer which I think he might have given with some little severity and yet with much truth to the animadversions which were made on the Board of Trade. I do not think that those remarks were at all necessary; whilst they rather diverted our attention from the subject before us. I do not wish, therefore, in any remarks of mine to say anything which would reflect upon any public department or upon any official personage. But I think as honest men standing up in this theatre, we ought to speak honestly what our mind is as to the effect of these numerous Rules of the Road at Sea upon collisions. In the good old time there was an idea that the man who was placed in charge of a ship was the proper person to command her. Now, however, there is an idea that the people who are to manage ships afar off on the high seas, are the persons who sit at comparative ease in certain offices at Whitehall. Those gentlemen who sit at a table in an office undertake to tell Commanders of ships what they are to do with their vessels under every conceivable circumstance. The old rule left it entirely to the judgment and seamanship of the Officer to get his ship out of difficulty. All that was laid down for him was one or two general principles, such as—"If you are "on the starboard tack you are to hold on your course. If you are on the port tack "you are to give way." The Captain of one ship was not to care what the Captain of the other ship thought, or to study how the other ship was to be managed. Now-a-days that is not the case, but every Officer is expected, with hands tied by a set of absolute rules, to command two ships instead of one. He is expected to command his opponent's ship as well as his own vessel. He has to judge of what his opponent is thinking of, and of what his opponent wants to do before he thinks of what he is going to do himself. This appears to me altogether an error in principle. If a principle were laid down by which the attention of each Captain could be exclusively devoted to the movements of his own ship, he would only be required to study the relative position of his own vessel, irrespective of what was passing in the mind of the Commander of the other ship; that would simplify the problems very much. And if that principle could be brought down to the simplicity of the old rule, which was in operation in my boyhood, experienced seamen would not have to sit down to study with so much laborious attention a large number of absolute rules, and to cram their heads with nursery rhymes. Even after a number of absolute rules are understood, it is not easy to determine in a moment on a dark or tempestuous night when a vessel is running very close towards you, and an error of memory might be fatal, which of the nine or ten rules is to be acted under. Acting thus, not on his own judgment and skill but upon memory, the Officer of one ship might by luck hit upon one rule, and his opponent think the case came under another of the nine rules. Even lawyers and judges sitting quietly in arm chairs at Westminster find it often very difficult to determine that which illiterate seamen are expected to decide off hand in dark nights at a moment's warning with imperfect knowledge of what the other ship is doing. Indeed the decision as to which of the nine rules is to be followed in a given case is rather a lawyer's than a seaman's question. Seaman-like skill is to be thrown to the winds, and the memory of an Order in Council and its official explanations and illustrations is what has alone to be considered. There are many reasons why collisions should multiply under such circumstances. The fact that it requires all these official explanations and official illustrations and so many Orders in Council, and all these lectures to make the present Rules of the Road at Sea understood, even by educated men, shows the difficulty of understanding them. Remember that, in addition to all these official printed explanations, it was necessary for a very high Officer of the Board of Trade, a most intelligent landsman, to go down to the East of London and to personally explain these rules to a seafaring population. I believe that that semi-official explanation was very clear indeed, and that those sailors who heard it understood the rules much better in consequence. But then every seaman was not present. There are somewhere about 50,000 masters and mates in the mercantile marine, and a great many Officers in the Navy. They were, unfortunately, not all in that East-end room, and, therefore, they could not all have the benefit of these personal semi-official explanations. Rules which require explanations upon explanations, whether by word of mouth or by Orders in Council, or by pamphlets, stand condemned by the very necessity of such verbiage. It is not necessary that the rules themselves or the explanations should be wrong, in form, to cause their removal. Such rules and explanations and nursery rhymes might be most valuable in a popular book on seamanship to instruct young men in the elementary portions of their profession. But when such rules and explanations are elevated into hard and fast laws, and are given a legal status, they assume a very different position from that of a midshipman's catechism. They then cease to be advices to young apprentices, and become destructive of all seamanlike experience and skill. Suppose Colonel Henderson were to draw up such precise and absolute rules by which cabmen were to guide their cabs in crossing Oxford Circus, what confusion and collisions would take place. He would have to draw up at least nine or ten rules. But he does not do anything of the kind. The Commissioner of Police supposes that a cabman knows how to drive his cab, and he merely lays down one or two general principles; and he then leaves the cabman to exercise his skill as a driver in getting out of the difficulty in the best way he can. That was the case also at sea in the good old days. We were then told which of the two ships should give way, and that vessel was to get out of the way in such manner as the seamanlike skill of her Commander might determine. But now-a-days a gentleman in a public office on shore sits down at his desk to tell sailors what they are to do under every conceivable circumstance in dark nights at sea. The whole thing appears to me erroneous in principle.

Captain Curme, R.N.: I wish to be considered as speaking merely as a Naval Officer, and not authorised by Lloyd's. I have only lately given up the command of an Indian troop ship, which I had for three years. Whether I understand the rules or not, is for other people to say. I think I do. There may be better ones, but I have never read them. I certainly do not think Mr. Lacon's are. I believe I know our present rules well, because I had taken a great deal of trouble to get them up; and the having commanded one of the Indian troop ships, will be admitted by some of you present to give the right to speak as with some experience. I believe also that the Order in Council of 1868 was a most excellent thing. It struck at the very root of mistakes. Mr. Lacon made a strong point of the detail of "green to green and red to red," &c., being entered into, but it was necessary to do this fully to show people that there are a great number of cases in which it was supposed necessary to move the helm when it was not. All cases are there shown in which it is not necessary to touch the helm, and these being eliminated, it is made plain that there are *very few* cases where it is necessary to touch the helm at all. The Order in Council put this in the plainest language. I consider that every unlearned sailor owes a debt of gratitude to Mr. Gray for those nursery rhymes which have been made so much fun of, because they are excellent for the purpose of helping people to commit the rules to memory. I cannot tell you how the instructions can be amended. I thought I could six years ago, but I do not think so now.

Captain Colomb, R.N : Unfortunately I have a good deal to say on this subject; but on this occasion I will not say it. I think, however we may agree with or differ from Mr. Lacon in his views, we must all be quite agreed that he has done his work to-night uncommonly well. I think myself that in those years that he has spent in agitating the subject, he might have effected a great deal more real good than he has done. I cannot say whether it is his misfortune or his fault, but he has the credit of being more an upholder of a particular set of rules of his own or others' devising, and less an upholder of a call which was very strong a little time ago, namely for an inquiry. I am afraid that the urging of a particular set of rules upon a Government department had the effect of checking a full inquiry into the whole subject, and I, having myself made a very extensive—I may say also, a very extended—inquiry into the matter, am quite persuaded that until there is full and complete inquiry held, and a report authoritatively issued by Parliament or some other competent body, we shall perpetually have these questions arising, and we shall have continued disagreements as to what ought to be and what ought not to be the Rule of the Road, and a constant increase in the number of collisions. Now I do not speak altogether without book. Before the loss of the "Amazon" and the "Osprey," it was my duty to go into this question of the Rule of the Road officially, not as to altering the rules, but because I discovered that the then Admiralty Rules, and the Board of Trade Rules, so to call them, exhibited a great discrepancy, and the question was whether our Admiralty Rules should be retained with the Board of Trade Rules, which had already been authoritatively issued to the Navy or abolished. In the middle of this inquiry came that wreck. After that time Captain Brent and I examined all the collision cases which had been tried in the Admiralty Court for the ten previous years, and since then there is hardly a collision case which has been reported in the public press which I have not examined and analysed. It is my habit to this very day every morning to read in the columns of the *Shipping Gazette*—where there is a perfect mine of wealth of that kind—to read the collisions reported since the previous day. In this way I have arrived at some very distinct conclusions. One is that the danger point for ships meeting is, as I have drawn it on the diagram, when their courses differ and cross at an angle of two points; the situation then exhibits the maximum danger, as ships whose courses cross at less than two points, as between those whose courses cross at more than two points. Then I have come to another very distinct conclusion. The facts which precede collisions are almost invariably these :—" X," as you see, observes a ship, or a light a little on her port bow, and she immediately ports. " Y " sees a ship or a light on her starboard bow, and she immediately starboards. These measures are taken as a matter of precaution. The result is, that they remove the point where the courses are crossing further to the right. But in doing that, both ships, as they are advancing, draw nearer to that point, and are getting into greater danger. Whether these be two steamers, two sailing vessels, a sailing vessel and a steam-vessel, these are the facts which generally precede collisions. We may look at what the number of the collisions are. These figures I have taken from the publication of Lloyd's Statistical Committee. They are worth notice. In 1866 there were 1958 collisions reported, of which 198 ships went to the bottom. In 1867 there were 2062 collisions reported, and 185 ships went to the bottom. In 1868 there were 1923 collisions reported, and 169 ships went to the bottom. In 1869 there were 2185 collisions, of which 157 ships were destroyed. The figures for 1870 are not yet obtainable.* I think simply on that statement of figures, without going one step further, you see that there ought to be a thorough inquiry into this subject. Not the adoption of any particular writer, not taking up this idea or that idea, but to go directly to the fountain head, ascertaining, classifying, and setting out exactly how the collisions occurred, and then we shall be able to apply a remedy, but not before. At present it is not known, and it is not considered generally, how collisions occurred, and that is for the very simple reason that it requires a great deal of hard work to get at it, and there are few people who have sufficient interest in the matter to take the subject up in that careful way. Now on the question of the Board of Trade action as to the rules, I hold it to be right in one respect; while, on the other hand, I greatly regret it. Before the explanations were issued in 1868, the Board of Trade had it in their power to have opened the question, and to have appointed, as the Admiralty wished, a Committee of Inquiry, who would have gone into the whole matter. Instead of that they did what I cannot altogether condemn, as I think it was a move in the right direction. They issued an explanation tending greatly to limit the indiscriminate use of the port helm, which was before that one of the greatest causes of collision. But when the Board of Trade issued the explanations, in terms, so to speak, of the lights carried by the ships, they ought at the same time, without a moment's delay, to have looked into the question of this carrying of the lights. That they did not do in any efficient way until last month. I must say in the orders that they have now issued to their surveyors, they have gone a great way, quite as far, perhaps, as any apparently larger description of legislation could have gone—I say they have gone a great way towards limiting the number of collisions by night. It is important to understand that it is by night that we want to limit the collisions. Ships are very seldom sunk in the day time. Two-thirds of the collisions that happen occur at night. Those collisions which happen in the daylight are attended with minor damage, and loss of life is rare. But at night the heavy collisions occur, and the greatest loss of life takes place. The Board of Trade have issued instructions to their surveyors, which go far towards restricting the law of port helm in a still greater degree. But it is not yet quite right. There is a growing danger that the law of "port-helm," that is, the indiscriminate porting of the helm, will become again the custom, unless the greatest possible care is taken of it. Only the other day in the Bristol Channel there were two ships, the "Leopard" and the "Northumberland." The "Northumberland" saw three lights very nearly right ahead, and in obedience to the order, she put her helm to port. The "Leopard," on the other hand, saw only a green light on her starboard bow; she did nothing; there was a collision, and the "Northumberland" was necessarily condemned in the Admiralty Court. All that remains to seamen of this judgment is, that it is still as ever, a safe thing to put the helm a-port. That judgment followed from a faulty fitting of the lights; and the danger of making your law in terms of the lights, is the difficulty of getting your lights to comply accurately with the law. Another point with reference to the explanations. Mr. Lacon stated that the Admiralty Court had refused to recognise the explanations. I think that is a strong term. I know two or three cases where a ship has been condemned by the Admiralty Court, for not porting her helm recently, where, if the explanation had been taken as the rule, they would not have been condemned. And though it is a strong term to say that the Admiralty Court refused to recognise them, it is not too strong to say that they are not yet sufficiently binding upon the Admiralty Court. The consequence, of course, in such a case as the "Leopard" and the "Northumberland," and the "E. S. Webb"—a very well known case—the tendency of both those cases, when the ship which ports is exonerated in the Admiralty Court, is still to encourage seamen to put their helms to port. I regret the Board of Trade action so far, because I think if they had inquired, they might have succeeded in obtaining a sound law, which would have bound the Admiralty Court, and about which there could be no doubt whatever.

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* The figures for 1871, not yet published, but since kindly furnished to me by Mr. Jeula, are—collisions, 2561, ships sunk, 176.

The CHAIRMAN: Our time is past, and unless any other gentleman wishes to address the meeting, I will call upon Mr. Lacon to reply.

Mr. LACON: I have no other answer to make but this, that I do not advocate any particular rules. I have brought this question before you; but there is an honourable member present to-night who knows that for the last eight months I have been urging the question of inquiry. Through him I have urged upon Her Majesty's Government to appoint a Royal Commission, because if you have a Royal Commission you can appoint upon that commission such men as Sir Alexander Milne, a man who occupies a very high position as a naval man in this country. The Government has not done so, and the question comes on in the House of Commons to-morrow night; Sir John Hay's motion is only for inquiry.

The CHAIRMAN: Allow me to return your thanks to Mr. Lacon. If only on the humanitarian side of the question, the importance of the subject cannot be over-rated. There is no doubt that great good will follow from a full discussion of the subject.

NOTE.—Mr. Lacon wishes to insert the two following rules, of which Sir John Hay has given notice in the House of Commons. There was no time to introduce them in his lecture, but they have received the approbation of the Cinque Port pilots, and the first also the concurrence of the French Government.—ED.

Lights Astern.

"Any vessel with fixed lights under weigh, seeing the lights of another approaching, " where her own lights cannot be seen, shall exhibit or wave a white light until such " vessel has passed."

Danger Light.

"Any vessel ashore or aground in any channel or fairway, shall extinguish her " fixed lights, and shall exhibit two white lights, placed horizontally about 3 feet " (1 French metre) apart, at the same height from the deck as the anchor light above " enjoined to be carried."

LECTURE.

Friday, May 17th, 1872.

General Sir WILLIAM J. CODRINGTON, G.C.B., in the Chair.

"THE RUSSIAN ARMY."

By Lieutenant Charles E. H. Vincent, 23rd Royal Welsh Fusiliers.

Mr. Chairman and Gentlemen,

Ere I enter upon the subject of the lecture that I am about to have the honour of delivering to you, it behoves me in a measure to explain my presumption in appearing in this theatre in other character than as one of the audience.

When I recently returned from Russia, I was no less flattered than surprised to receive an invitation from the Council of this Institution to read a paper on "The Russian Army."

Although my journey had been undertaken entirely at my own instigation and expense, in order to learn the language, I had been afforded such unusual opportunities of studying Russian military organisation, by the condescension, kindness, and courtesy of the Generals and regimental Officers quartered in Warsaw, that after some consideration I decided to avail myself of the privilege offered me by the Council; but, I did so only with the conviction that I might rely upon your kind indulgence to pardon any errors into which my inexperience might lead me, or any deficiency in capability of welding my matter into an interesting and complete form. I little thought, however, that I should be assigned the difficult task of replacing so able and experienced an Officer as Surgeon-Major Wyatt, whose inability to fulfil his engagement through indisposition you cannot fail to deplore less than I do myself, and I must further claim your consideration on account of the very short time that was allowed me to prepare my lecture.

Figures are stubborn, indigestible, and uninteresting facts; their citation must be wearisome to all, but unfortunately they are the only means by which numerical force can be designated, and, unless I err, numerical force is one of the chief features in the military organisation of a country. However, I will endeavour to be as sparing as possible in this particular.

Although in describing the Russian military organization I shall use the present tense, it is well that you should understand that some of the provisions relative to length of service, levying, reserves, &c., are only in contemplation, or exist only in theory; no time having elapsed for them to be put into practice.

How necessary army reform was in Russia you will readily comprehend, when I tell you that under the old system, the soldiery were taken exclusively from the very lowest class of peasantry, by a complicated system of forced service; that the Officers were deficient in number, character, and education; and that no defined system of reserves existed. The Reorganisation Commission has but just concluded its labours, and its measures still lack the Imperial sanction. However, there is sufficient reason to believe that they have adopted the primitive project of reform as laid down in the ukase of November 16, 1870, somewhat modified it may be, to justify my speaking of it as actually existing, although the whole system is really only *in transitu*.

Rather more than seventeen years ago, the Emperor Alexander II succeeded to the throne of All the Russias, vacant by the decease of his father Nicholas. The constant news of the bitter sufferings of the imperial troops, and of their adverse fortunes before the Allied Armies, served not to soothe the latter days of that austere monarch. On a camp bedstead, in a poorly furnished chamber, appointed by himself, in order to share in a measure the hardships of his soldiers, the Emperor Nicholas Ist breathed his last, and the autocracy of Russia passed into the hands of his more liberally-minded son.

The position of the Emperor Alexander Nicholaievitch,* on his accession, was one fraught with difficulty—engaged in a hopeless contest, which absolutely impeded all commerce and enterprise, and brought distress and ruin to nearly every door. Peace was a matter of necessity, and in little over a twelvemonth, the treaty of Paris checked hostilities, and freed Russia of the invader, without any serious concessions on the part of the defeated. On a long period of peace and prosperity the future of Russia now depended, and to carry out such a policy was the firm resolve of the Emperor.

A deep and searching inquiry into the evils existing in every civil and military institution; the consideration of the best means for removing them; and minor innovations, occupied some years, until on the 3rd of March, 1861, the decree went forth proclaiming the emancipation of the serfs from their dependency on their proprietors. That decree forms the great modern landmark in Russian history; it enables all owing allegiance to the Tsar to strive on terms of equality in the market of intellect and industry, and in future ages every Russian will have to look back to that decree as the true source of the greatness and prosperity of his country, and it will be for ever associated with the name of its Imperial promulgator, and his faithful and zealous commissioners, the Generals Rostovzoff and Milutin.

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* The "vitch" after the name of a man signifies "the son of," and "effna" after the name of a woman, "the daughter of." Thus, "Alexander Nicholaïevitch"—Alexander, the son of Nicholas; "Katerine Alexandreffna"—Catherine, the daughter of Alexander. It is the custom in Russia thus to address people, even strangers, without prefix or surname.

But I must not permit myself to dwell longer on the civil administration of the Emperor Alexander. I must pass on at once to the remarkable reforms effected in the Army, which can only be spoken of with respect by Englishmen, when they think of the salient proofs of courage it gave, contending as it did in the Crimea against such fearful odds.

The Polish insurrection, and the campaigns in the Caucasus, were events almost forgotten when once over, and brought little teaching; but the war of 1866, and the mighty hosts which battled in the Bohemian arena, clearly indicated the necessity for securing on a firmer basis the constant supply of the proper complement of warriors to defend the honour, safety, and integrity of Holy Russia.

Austria lost no time in profiting by the lesson so direfully read her by Prussia, and Russia made equal haste to reap the benefit of the brilliant example of one rival, and the bitter experience of another. Accordingly, on the 16th of November, 1870, an imperial ukase was issued, proclaiming the liability to military service for every Russian male.

It now fell to the lot of the Minister of War, Infantry-General Milutin (brother of the emancipation commissioner), assisted by the aforementioned commission, to arrange the details of the new system, to organise and dispose the vast force thus obtained into separate bodies, affording each other mutual support, capable of immediate concentration, yet not so massed as to nationality or locality as to admit of the outburst of independent political feeling. But these were not easy conditions to carry out in a country extending over 7,770,882 square miles, with yet imperfect railway communications, with a male population of over 36,000,000, and with a portion of the empire decidedly disaffected. Were the new law of universal service to be carried out to the letter, and all males of a serviceable age called to arms, a force of some 6,000,000 would be the result, or 4,000,000, allowing a liberal margin for those physically unfit, or otherwise exempt.

Now an available army of 2,000,000 troops was justly considered sufficient to meet all due requirements of the empire, either for internal or external war, and a period of about ten years was allowed for it to reach that maximum number. It was, therefore, computed that an annual contingent of 25 per cent. of the youths who had attained their 21st year would furnish a sufficiently numerous body to keep up the standing army, to augment it to full war strength, and to keep it constantly supplied with fresh men, trained in the regular service, by the formation of strong and reliable reserves. But the remaining 75 per cent. will not be freed from their share in defending the soil, for, organised locally, and drilled periodically, they will be bound to serve till the completion of their 36th year in the militia, to whom in time of war the preservation of order in the interior, the garrisoning of the towns and fortresses, and the levying and training of the recruits for the field forces will be confided. Thus the whole of the bayonets composing the active army of the Tsar will be free to take the field against a foreign foe. The selection of this more or less fortunate moiety, according to the feelings of the individual, will be decided by the drawing of lots; those that fall within the prescribed number being theoretically allowed no exemption by birth or fortune (practically a substitute will probably be obtained on the present terms, 800 roubles), although, of course, certain social and physical conditions may assign an available conscript at once to the militia, and preclude him from the drawing.

The period of service will extend over fifteen years, from the end of the 21st to the termination of the 36th year. In the case of those destined to serve in the regular army, seven or eight years will be spent with the standards, and the remainder with the reserve. Many, however, desire that the former period shall be reduced to five or six years, according to the capacity of the individual, so as to lessen the number of men on foot in time of peace, and that the soldier may go as soon as possible, and propound among the still benighted lower orders the teaching and education he has derived in his regimental experience. Although it is reasonable to suppose that five or six years is sufficient to form a soldier, the proposition is dreaded by those accustomed in their youth to see a soldier serve for life, or until incapacitated by wounds and infirmities.

The supreme direction of the Russian Army lies with the Emperor, who has his Chancery at the Ministry of War.

The Minister receives and prepares for His Majesty the reports of the twelve chief sections, among which the administration of the Army is divided. These twelve departments are—

1. The Imperial Chancery.
2. The Council of War.
3. The Superior Military Tribunal (Court of Cassation).
4. The Chancery of the Minister of War.
5. The Head-Quarter Staff, administering the cavalry and infantry, with their technical schools, and having all staff corps and institutions under immediate control.
6. The Intendance Department for the pay, supply, and clothing of the Army.
7. The Artillery Department, administering the artillery, with its technical schools.
8. The Engineer Department, likewise administering that branch, and controlling all matters connected with fortifications, and the quarters of troops.
9. The Army Medical Department.
10. The Educational Department, controlling only preparatory schools; technical academies being managed by their several departments.
11. The Administration of the Irregular Troops.
12. The Department of Military Justice.

Since 1864 Russia has been divided into fourteen military districts, besides the Cossack Province of the Don. These districts are—

1. St. Petersburg.
2. Finland.
3. Wilna.
4. Warsaw.
5. Kieff.
6. Odessa.
7. Harkoff.
8. Moscow.
9. Kazan.
10. Caucasus.
11. Orenburg.
12. West Siberia.
13. East Siberia.
14. Turkestan.

At the head of each district is a general Officer, who, if simultaneously invested with the civil administration, is termed "Lord Lieutenant" (Namiestnik) in Poland and the Caucasus; and in Finland, Wilna, Odessa, Siberia, and Turkestan, "Governor-General." The head-quarter staff is divided into—

1. The District Military Administration.
2. The Intendance Department for pay, supply, and clothing.
3. The District Artillery Department.
4. The District Engineer Department.
5. The District Medical Department.

Moreover in each military district there is a superintendent of the local troops, termed "local divisioner," and in each government a "local brigadier," who, besides commanding the local troops, is charged to keep the whereabouts of the men on furlough in view, and when occasion arises, with the levying of them.

We see, then, that the Army is distinctly divisible into three heads—

1. The Field Army, composed of the standing Army, augmented by its reserves of trained soldiers.

2. The Irregular Troops, consisting of both cavalry and infantry, and who are raised only in time of war.

3. The Militia or local forces, who have but a *cadre* peace establishment, and who may be supplemented to any extent by a *levée en masse* of the population.

It is, however, almost entirely the first category that must occupy us this afternoon, *i.e.*, the standing Army and its reserves.

The standing Army is composed of the troops of the Guard and the troops of the Army or line, the former possessing enormous privileges over the latter; in interchanging, rank in the Guards is two places higher than in the line, each composed of infantry, cavalry, artillery, and engineers. Although all, or nearly all of the regiments are designated by the names of localities or of illustrious personages, as well as by their regimental numbers, they are in no way tied to fixed localities, nor do they draw their recruits or receive their reserves from particular districts. No doubt much valuable influence of local pride, old association, and *esprit de corps* is thereby lost; but such a system is rendered partially necessary by the vast area of the country, the imperfect communication, and the disaffection of some provinces.

The tactical and administrative unit in time of peace, is the Division for cavalry and infantry, and the Brigade for artillery, engineers, and rifle corps. In time of war these several units are drawn into *corps* *d'armée*, and the corps into armies, and employed as necessity and occasion require.

The field troops of the Russian Army are composed of 47 divisions of infantry, 8 brigades of rifles, 10 divisions of cavalry, 50 brigades of field artillery, 8 brigades of horse artillery, 5 brigades of engineers, with a numerical strength (according to semi-official, but not absolutely reliable documents) in time of peace of 33,043 Officers and 735,539 men, and in time of war of 43,355 Officers, and 1,358,672 men, with 1,656 guns.

The cost of each soldier is about £25 per annum, and the war budget amounts on an average to about £21,000,000 sterling.

I ask you, now, gentlemen, to associate yourselves with the conscript. According to your talents, physical appearance, and proportions, you are assigned to one of the arms of the service, and while superior mental faculties procure you admission to the scientific corps, a long thigh, and previous association with horses, will be your special qualification for the cavalry. The recruits for the cavalry of the guard are selected by the Grand Duke Nicholas Nicholaievitch, the elder, himself. Recruiting in the provinces is not left to the local authorities, but is superintended in each district by a special Imperial Commissioner, appointed annually.

After six months' preliminary training with the district reserve battalion, squadron, or battery, where you receive your first uniform, you are appointed to a regiment. Unless personally gifted by nature, your lot lies with the Army; were it with the Guard, you would be housed in barracks, wooden sheds, truly, and with 70 or 80 comrades in the room, but yet more comfortably located than if billeted in a peasant's hut. The erection of barracks is projected for the whole Army, but it must be long ere they exist. Meanwhile the regiments are billeted in the towns, and when sufficient room is not to be had in one locality, they are quartered in contiguous villages. During the summer months, May to October, the whole regiment is brought together under canvas. Eight years (but shortly it will be less) you spend in this way, and then you cast aside the permanent military yoke, and repair to the reserve. Perfectly free in all your actions, you can reside where it pleases you, and change your residence at pleasure, being only required to signify your movements and actual address to the local authorities. On the outbreak of war you are summoned—if your address is known—and are attached to the nearest regiment at hand of your branch, where arms, clothes, and equipment sufficient for the complete war establishment lie in store. I said, "if your address is known," because it is feared that many a Muscovite warrior omits to give his correct address to the local authorities, and that on the call to arms, more than one voice would not be heard when the roll was read over on the day of rendezvous.

But absolving you from your connection with the Russian conscript, I must retrace my steps, and enter upon his regimental life. Docile and willing though he be to learn, hitherto fortune has not afforded the opportunity to him or to his fellows, and the long frosts and heavy snows of winter, which prevent all military exercise, besides an occasional route march, must be taken advantage of, to instil the education so necessary to the welfare and social development of a people. Nearly every day, then, from November to March, for four or five hours, the Officers do the duty of schoolmasters, and the captain, or subaltern Officer under his direction, takes the greatest interest in the relative progress of his men. Periodical examinations take place, when a small prize in money, or the favourite spirit (oodki), or the accordance of some special privilege, is sufficient to excite the greatest emulation. The teaching comprises arithmetic, reading, writing, and simple lectures on military art, illustrated on the black board.

But it may well be thought that in so poorly educated a body the difficulty of obtaining suitable Non-commissioned Officers must be immense. So it would be if the Russians had not met the difficulty in the face, and adopted such resolute measures as not only to counteract it, but also to form a body of men who, after the termination of their military service, are admirably suited for the posts of national school masters, the want of whom is one of the chief obstacles to the educational progress of the country. Forgive me, then, if I enter somewhat tediously on what is one of the most remarkable features in the Russian regimental organisation.

In every regiment of cavalry, or infantry, or battery of horse artillery, or brigade of field artillery, there exists a Non-commissioned Officer's school, conducted by two or three Officers entirely told off for that purpose. Such men, who are of good appearance and character, who can read, write, and sum, are eligible to enter the school, after two years' service, if they have attained the grade of Lance Corporal. Going through the school, however creditably, does not ensure promotion to the non-commissioned ranks, it only entitles to it; skill in arms, tact in command, and physical aptitude, are necessary qualifications for the first graduate. The course of study lasts two years; during the first, the more elementary subjects of education are attended to, such as history, geography, arithmetic, composition; and in the cavalry and artillery, elementary veterinary surgery, &c.: whereas during the second year the studies are more military, and include military history, field fortification, tactics, and also mathematics. You may smile at the word "mathematics," but you must recollect that the Russian Army is the school of the country, hence the necessity of giving a sound general education; and you would have been no less astonished than I was to see a pupil selected apparently indiscriminately by the General accompanying me, and ordered to bisect a given straight line, according to Euclid, on the black board. You would have been astonished, too, on entering a regimental schoolroom, to find the men listening to a lecture on tactics, and to see a relief-model of the environs; on inquiring its purpose, for the General to order two pupils to stand out, to hear him give them an extended operation to work, the one to advance with such an object against the other defending; to see painted tin models of companies and battalions at once worked, and when the General stopped the really sham fight, to hear each of the men in turn give a succinct account of his movements, dispositions, and intentions, corrected now and again by his

Officers, but never assisted; to see another man stand out and make his dispositions for throwing an advanced guard across the Vistula, describing them the while. Nor would your astonishment lessen when a fourth pupil described the general geographical features of England, enumerated our chief towns, traced the course of our rivers; when a fifth, starting from London, followed the track of a ship to St. Petersburgh, naming the countries, their several capitals and sovereigns, by which he passed; when a sixth, starting from some far distant spot in Russia, traced the course by canals to St. Petersburg, enumerating the principal places on the route, and their capabilities for billeting troops.

You may think, gentlemen, that I am exaggerating, but you have, I am sure, but to steer eastward to have the opportunity of verifying my statements, met, as I know you will be, with the courtesy, hospitality, and frankness which distinguish Russian Officers. Meanwhile accept my facts. The pupils may have been selected, but I have no reason for supposing them to have been so, especially as I am not referring to any one particular regiment.

In the summer, field fortification is taught out of doors; but in the winter, when all earth is hidden by many feet of snow, a box about six feet by four, filled with sand, answers the purpose. In one class-room I saw this box, in it were various beautiful models of field works. I expressed a wish to see the pupils at work. In an instant the surface was as level as this table, the four first men stood out, and in twenty minutes, with tiny wooden scoops, a cavalier and a sunken battery were thrown up, with revetments as firm, and slopes as regular as all the time and all the skill of an army of engineers could make them. A sufficiently good scholar may pass at once into the first class, and thus absolve himself of the school in one year. The pupils are entirely separated from the men, living, sleeping, and eating apart, although they generally revert to their companies for the great annual manœuvres. You can easily imagine what a highly trained set of Non-Commissioned Officers such a system must form.

A commission is within the reach of any non-commissioned Officer who passes the necessary examinations; if these examinations be passed and the commission not accepted, an annuity of about £15 is added to the pay during service.

I will now pass from the subject of education to that part of the soldier's life which he shares in common with all men, the amount he earns, and what he eats and drinks. Miserably paid, and almost worse fed on that which is not calculated to make men thrive, on black bread, on a sprinkling of meat, mixed up with rice and a herb which makes it sour; with "quass," a terrible sour, perfectly non-intoxicating beverage to drink, the Russian soldier flourishes, and so flourishes that he can endure almost anything. His spirits and good humour, too, never flag; and in every company, squadron, or battery, there is a musical troupe, who sing and dance admirably. When marching at ease, the troupe always goes in front, and enlivens the route by comic singing and curious antics, although they never lag or get in the way.

The question may be asked, is the discipline of the Russian Army all that it ought to be? If discipline is measured by the amount of crime, Russia yields the palm to no country. Drunkenness exists, but to no great extent. The men are honest (the company's cook goes alone to market to purchase the day's provisions) and submissive as individuals to any degree. Two or three prisoners in the morning is not an excessive allowance to three battalions. Is discipline, then, to be estimated by the respect shown to Officers? Again Russia is nothing behind, for saluting and military attitude in address is never disregarded.

But now and again you are confidentially told that the orthodox cry of Russian soldiery when ordered to execute something, "we gladly obey" ("Radi staratsyah"), comes out sulkily or is replaced by a dull growl. I dare make no assertion on this score; but in speaking of discipline, we must speak of the Officers, on whom it so much depends. I would that I could avoid mentioning them. For all the kindness and hospitality they showed me, and which I can never forget, they are justly entitled to the warmest expressions of my thanks, yet I must honestly state my opinion, and I know them to be too right-minded to misinterpret my sentiments.

The non-existence of what the Germans call the "Kleineadel," and we the squirearchy of a *haute bourgeoisie*, a class blessed with small pecuniary means, yet endowed with the proudest patrician feelings, renders the question of officering the Russian Army one of most serious difficulty. Although Russia is essentially a military nation, where uniform is the only passport, the attractions of the bar, of commerce, of literature, and of art, are every year luring more and more Officers to change their ill-paid and hard worked profession. Ere long, the Government will have to take very stringent measures, for now at least 5,000 Officers are wanting, and principally in the scientific corps, whose members have been called away to construct and superintend the new railways, roads, and bridges all over the country. Another very serious element in the present Officers of the Russian Army is the number of Germans, whose presence in certain contingencies would be a great embarrassment; but they could ill be spared, either as to ability or numbers.

I will not ask you to follow me through the entire curriculum of an Officer's studies; suffice it to say that military preparatory schools exist in great numbers, and receive pupils from a very early age. Those who decide on the military career, proceed at about 16 to one of the technical schools, from whence at the age of 19 or 20, having passed the ordeals which block every stage, they obtain their ensigncy, then follow the various grades without further examination. A second captaincy is reached in about eight years' service, and then merit may give the epaulettes of a general in a very short time (*i.e.*, 9 or 10 years), or you may be left to languish in command of a company or battalion, awaiting the gazette and the promotion, which never come.

An effort is being made to assimilate the off-duty life of Russian Officers with our own, by the establishment of regimental messes, but expense and the habits of the country put great difficulties in the way. Forbidden on any account to appear out of uniform within the confines of the empire, as Russian Officers are, the reputation of the entire class frequently suffers from the delinquencies of a few members, and would those agitators who desire to see British Officers wear their uniform in public but visit a few of those places of more popular than proper entertainment abroad, and there witness the scenes they wish to reproduce in these islands, English Officers would have little cause to fear that one day the outward sign of H.M.'s commission, the uniform, the coat of honour, will lose the influence and prestige it now possesses, by too frequent and vulgar association.

I said just now that the Officers themselves instructed the men. Now it is quite open to doubt whether employment in such non-military capacities, and the constant intercourse therein involved, add to their reputation with the men, and the respect in which they are held.

It is curious how far the usages of society between equals are observed between the Officers and the men. A subaltern drilling a ride or a squad, a Captain inspecting his company, a Commanding Officer holding a parade, a General reviewing his brigade or division, always commences with the salutation "Zdaróvyah rebarta" (good health my children), to which the men reply, "We wish it also" (adding the title of the Officer they address), and when on Imperial parades, the cry, "We wish good health also to your Imperial Majesty" (Zdarovyah jeliém váse Imperátorsko veléchestvo) peals forth from forty thousand throats, the effect is superb. Yet the inconvenience of having to greet each individual soldier in your path must be great.

The degree of education possessed by Russian Officers varies considerably between the Guard and the Army. The supposition that every Russian Officer is a good linguist is entirely erroneous. In the cavalry of the Guard, nearly all know French colloquially, many speak German, but few can write grammatically in either language. In the infantry of the Guard, such knowledge exists in a smaller proportion, and in the troops of the Army it is a very great exception to meet an Officer conversant with a foreign language.* The theoretical training of young Officers is but little attended to, though the practical teaching is very extended. In some garrisons and towns, military conferences are held, and but little else is done at present. Candidates for the Staff are required to pass through the Nicholas Staff Academy at St. Petersburgh; but the number who offer themselves is so comparatively small, that many Staff Officers have to be appointed directly from their regiments. It is in the numerical and intellectual deficiency of Staff Officers that one of the weakest points of the Russian Army lies. By a recent regulation, promotions in the Staff corps will not take place without an interregnum of regimental duty.

In the case of first commissions there is no probationary period, but an Officer of the Army desiring to enter the Guards, by which he loses two ranks in seniority, is put on his social trial for six months, during which he wears his old uniform before he is definitely accepted. Promotion goes by seniority up to the grade of Lieutenant-Colonel, whence it is so entirely by selection that none have access to the seniority lists. There is no printed nominal roll of the Officers. About six weeks' leave of absence is granted annually, but the accumulation of two or three years is frequently taken advantage of for purposes of foreign travel. The pay is miserably small, although increased of late, but it is supplemented by periodical pecuniary rewards for the satisfactory performance of duty. Another rather curious custom is the giving of orders and decorations; yet the pay is so small that perhaps it is necessary to establish some equivalent. The breast of many a youth who has never seen a shot fired in earnest, glitters with ribbons and orders, though lacking the cross-swords which distinguish those obtained in the field. The possession of one order for a certain length of time entitles to another, and so on. The desire to obtain these flimsy ornaments is astonishing, and is well illustrated by the reply of a young, rich, and smart Officer of Cavalry to my query as to why he accepted the monotonous post of quartermaster (the regimental paymaster and quartermaster are appointed by the Commanding Officer from the subaltern rank, and held during his pleasure), "C'est evident on peut obtenir des décorations;" one or two years in such a post entitling him to some order, which in time would be supplemented by a handful. Russian Officers are allowed to marry, but must first deposit 5,000 roubles as a guarantee that they possess the means.

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* The fact that their language embraces nearly all the sounds of European tongues enables Russians to acquire a far greater purity of accent in foreign dialects than is attainable by other nations, and hence the foundation of the popular error.

There are four departments, which belong to every branch of the service, the Ecclesiastical, the Transport and Commissariat, and the Medical. To every regiment and battery is attached a clergyman; and in every barrack or camp is an appointed place for divine worship. Attendance is entirely voluntary, but there are very few absentees. The Russian soldier shares the religious character of his countrymen. A church in sight, and the soldier, the sailor, no less than persons of their class in other walks of life, will take off their caps and devoutly cross themselves. Few men, and no company, squadron, battery, or regiment are without their patron saint, whose image they always keep near them. On the march and in the field, this picture has its place in the baggage waggons, and at nightfall, be it where it may, it is surrounded by devout worshippers, whose prayers are led by a chosen non-commissioned Officer.

It is in the solution of that difficult problem, "Army Transport," that General Milutin has perhaps excelled. In Russia all military transport is managed by the several corps. Every cavalry regiment has its waggons, in peace and war, at the rate of one transport waggon per squadron, for six days' provision, and one ammunition waggon per regiment, with 30 rounds for each carbine, and 20 for each pistol. Every infantry regiment has its one three-horse transport and one ammunition waggon per company; the horses belonging to the regiment and being driven and looked after by them. In peace, but one waggon, and that horsed by only two horses, is kept up per company. If the Officers cannot find room for their baggage on the squadron or company-waggons, or on the one extra allowed them, they are permitted to have their own conveyances. The horses are generally driven in hand by one soldier. The transport waggon contains provisions for six days, and the ammunition waggon 40 rounds per man. Besides the one transport and the one ammunition-waggon per company, each regiment has an orderly-room waggon,—which contains the lithographing press, by which all regimental orders are printed and sent to each Officer—preventing the necessity of playing hide and seek with the orderly corporal,—the pay-office waggon, four ambulances, one hospital cart, one medicine cart, and the 1st regiment of each division; a band-waggon, but these are horsed only in time of war.

With regard to the Commissariat, it is impossible to say how far it is prepared to stand the test of an external campaign.

Although the deficiency of medical officers is very serious (but much less so than during the Crimean war), the Medical Department of the Russian Army is well administered, or rather, the regulations which govern it, are wise and provident. To provide a due number of surgeons, the Government gives a free education at the medical college at St. Petersburgh to such students as engage to serve three years in the Army when called upon. In the field each company is attended by an apothecary provided with proper medicaments and surgical appliances, besides which the officers' servants and unarmed men are formed into a body, working in action by companies, taught and instructed in the leading principles of military surgery, and drilled periodically in the most approved methods of removing the wounded from the field, and affording them temporary relief. Moreover, in many regiments, the senior surgeon gives periodical lectures to the Officers and men on the first steps to be taken when wounded if skilled assistance be not at hand—a system, the utility of which it is not for me to enlarge upon—and it is in contemplation to provide each man with a roll of lint. The present sanitary condition of the Russian Army is considered to be in all respects satisfactory, although consumption and rheumatism brought on by the poor lodging-accommodation of the troops, are decidedly on the increase. All slight cases are treated in the regimental hospitals, whereas specific and serious diseases are sent to the divisional hospitals.

Here I take the liberty of giving expression to a passing idea of my own, which found some favour with those to whom I mentioned it abroad, but regarding the utility or practicability of which, I can give no opinion. It being the unanimous opinion of those who have been through the late wars that the brassard on the arms of the Army Hospital Corps and surgeons, the red cross on ambulances, and the flag of the Geneva Convention, are not sufficiently conspicuous to protect the trains of wounded and those engaged in succouring them, from fire, in the mist and confusion of combat, and it being highly desirable in the merest interests of humanity to prevent such destruction as far as possible, that an international convention be proposed to clothe all surgeons, hospital assistants, apothecaries, bearers of the wounded, and drivers of ambulances in a tunic of white or other conspicuous colour, entirely peculiar to them, with trousers of a colour peculiar to each nation, to prevent persons in this, so to say, neutral garb getting through the outposts and obtaining information of the movements and intentions of the enemy; that all ambulances be painted white, and horsed solely with white or grey horses, which must consequently be excluded from the other branches of the Service, and used as chargers by surgeons and unarmed men, employed solely on the field to look after the wounded. All fire on persons wearing the uniform agreed upon, or upon waggons thus painted and horsed, to be strictly forbidden.

I am well aware that such a proposition cannot find favour with many, and notably with the gallant Scots' Greys and the Grey Battery, but I venture to submit that such a conspicuous colour is unsuitable for field operations, and the proof of it lies in the exclusion of white or grey horses from the French service,—while they were formerly employed, almost exclusively, by the Army Reorganization Committee,—on account of the mark they offered for artillery fire during the late war, and their evident unsuitability for vedette duty. In Prussia and Austria but few grey horses are used in military service, and in Russia the country is comparatively destitute of them.

I now propose briefly to treat on the separate details of each arm of the Service, its armament, equipment, and peculiar character, having already endeavoured to set before you the points they share in common.

The Infantry

as the most important, the most numerous, and the most efficient arm of the Service, shall first occupy our attention.

The Russian footmen, ready to spring into action at the signal of the Tsar, are composed of:—

10 Regiments of guards, each with 3 battalions.
14 Regiments, of 3 battalions of Grenadiers, of which 2 regiments are attached to the Guard.
4 Caucasian regiments, of 4 battalions of Grenadiers.
148 Regiments, of 3 battalions, of Infantry of the Line.
12 Caucasian regiments of infantry of 4 battalions.
4 Battalions of Rifles of the Guard.
20 Battalions of Rifles of the Line.
4 Caucasian Rifle battalions.
4 Turkestan Rifle battalions, therefore 188 regiments, with 580 Infantry and 32 Rifle battalions, massed into 3 Divisions of Infantry of the Guard.
4 Divisions of Grenadiers.
40 Divisions of Infantry of the Line, each of about 12,000 combatants.
8 Brigades of Rifles.

Every battalion of infantry consists of four companies and one rifle company. When the three battalions parade together, the rifle companies, each bearing the number of its battalion, are brought together into one battalion. The companies are numbered successively throughout the regiment. Thus the first battalion has companies 1 to 4; the second 4 to 8; and the third 8 to 12. The regiment is commanded by a Major-General in the Guards, and by a full Colonel in the Army, and each battalion has a Lieutenant-Colonel at its head. The regimental staff consists of—

4 Field Officers, 1 Commanding Rifle Battalion, a Regimental Adjutant, a Paymaster, Quartermaster, Musketry Instructor, an Officer in command of the non-combatant company, a Drum-Major, a Trumpet-Major, 1 Surgeon-Major, and 3 Assistant-Surgeons, 1 or 2 Chaplains, and the non-combatant company, in which are clerks, mechanics, train soldiers, and Officers' servants.

The battalion staff consists of—

A Battalion Adjutant, a Battalion Drum- and Trumpet-Major, and a trained Apothecary.

The strength of a battalion of Infantry is regulated by four scales—

(*a.*) The war strength, with 900 rank and file, of whom 60 are unarmed in reserve.
(*b.*) The augmented peace establishment with 680 rank and file, of whom 40 are unarmed in reserve.
(*c.*) The peace establishment with 500 rank and file, of whom 20 are unarmed in reserve.
(*d.*) The cadre establishment with 320 rank and file.

According to these four standards, the number of Officers and Non-commissioned Officers is determined. A Captain or second Captain is in command of a company, with a Lieutenant, Sub-lieutenant, and Ensign. In time of peace one of these Officers can always be on leave at a time.

On the war establishment a company consists of—

1 Junker (a candidate for a commission, qualifying for it in the ranks instead of at the War School).
4 Senior Sergeants.
12 Junior Non-commissioned Officers.
20 Lance Corporals.
148 Privates.
1 Pay-Sergeant.
3 Drummers.
3 Buglers.
1 Armourer Sergeant.
12 Privates in reserve.
1 Apothecary and 1 apothecary pupil.
4 Officers' servants.

In all 211 non-commissioned Officers and men. The rifle companies have an additional Subaltern and Officers' servant, 5 buglers and no drummers.

The Russian infantry is at present armed with the Krinck converted rifle, but the Berdan breechloader will shortly be issued. The rifles of all but the rifle companies, and eight picked shots per company, whose sights are adjusted to 1,200 yards, are sighted only up to 600 yards, to prevent that chance-shooting at impossible ranges in which the French troops during the late war wasted their ammunition. The men carry 90 rounds apiece, 15 in a pouch on each side of the clasp of the waistbelt, and 60 in the havresack, besides which 40 rounds per man are carried in the company transport waggon, and 60 more with the artillery reserve. Bayonets are always kept fixed, and besides the bayonet the troops have a short sword so adjusted as not to bump against the leg on the march. The uniform is grey, the field head-dress a small chaco, the belts and straps are white in the Guard, except the rifle companies, who have black, and in the Army all wear black. The knapsack is smallish, but heavy. Altogether the soldier carries 68 lbs., including his three days' provision. The Officers and colour sergeant have a curved sword, and a pistol in a black leather case on the right hand side of the belt. The regimental colour is carried by the most distinguished non-commissioned Officer.

It is improbable that the Russian infantry soldier has any rival on the march. With their trousers tucked into their long boots, the troops step out so fast that if once 100 yards ahead of you, no walking effort will catch them, and thus they can go on day after day, existing on food which would leave our men to starve. Their proficiency, too, in gymnastic exercises is very great. Nor is this confined solely to the infantry; for there is no barrack room throughout the service which is not furnished with a wooden horse and parallel bars, on which the company practise daily throughout the winter under their Officers, and in summer, regular gymnastic apparatus is established on every camping ground. The feats they perform, fully accoutred, cavalry soldier as well as infantry, are truly wonderful. At the bayonet exercise, also, their proficiency is of no mean order, for, stimulated by small prizes, they have the most exciting matches with each other; and to teach them to thrust accurately, a straw ball is suspended from the ceiling, and the men compete, under direction, in striving to make it swing straight by a direct centre thrust. They also practise thrusting at a straw figure, behind which the instructor stands parrying the blows.

The movements of the Russian infantry are very loose, though very rapid. For instance in wheeling upon a pivot the men scramble to their places on the word "march." The drill is supposed to be based upon that practised at the Model Battalion, to which one man is sent annually per battalion for two years.

The order of march is generally in column of sections, though movements in fours are frequently performed. The Captain of a company is in front, attended by the bugler and "jalonneur," or marker, who has a small flag fixed into the muzzle of his rifle. Each company has a different coloured flag, and the number of the company thereon. In camp it is placed in the ground in front of the tent of the Company Commander. A subaltern is on the right of each section.

To prevent the men falling into the habit of halting before an enemy by doing so in peace manœuvres, when friendly foes meet, the men charge through each other, holding their rifles perpendicularly aloft. Many a little accident frequently results from a falling bayonet, but the men never lose their temper and they enjoy the fun. On one occasion, when visiting the Lithuanian Regiment of the Guard with their Commandant, General Baron Korff, his Excellency asked me what companies I should like to see turned out. Being pressed, I said the rifle companies of the two first battalions. He had the calls sounded, and in two minutes the companies with their Officers were falling in on their private parades; in three, they were doubling towards the centre of the enormous square from opposite corners of the barracks, in five, the respective commands "front and rear turn" brought them into collision. Over went at least twenty on the slippery ice and snow, but in another minute both companies were doubling back by sections to their parades. In eight minutes from the time the bugle sounded, the men were dismissed, had deposited their arms, and were on their way to the canteen each to drink the glass of *vodki* given them by the General. There is a regimental canteen, but on a very primitive scale, for out of the farthing or so per diem that the Russian soldiers clear, there is not much margin for extravagance, nor do they want much, for they don't smoke, and only drink periodically.

Throughout the summer months infantry regiments are encamped, and then all sorts of manœuvres take place; but even in winter the bugle sometimes sounds at sunrise for a company to turn out, and off it is instantly sent to a distance of 20 or 30 versts ($\frac{7}{8}$ of a mile). At noon another is dispatched to intercept its return. The General rides out to witness the *rencontre*, which he criticises in that night's orders.

This last winter the troops at St. Petersburgh marched by brigades 80 miles out and 80 in, being but a week absent. They took their provisions with them, and were billeted at night in the villages. Although the thermometer had never risen much above zero, Fahr., the appearance of one brigade on parade at 2 o'clock, before the Emperor, on the day it came in (having done the last stage that morning), was admirable, both as to men and horses. The men were clean, and marched past as freshly as if just out of their beds.

I have already mentioned the company-transport, the company organisation for providing for the wounded; but to a yet greater degree does General Milutin endeavour to perfect the Russian infantry. Ten men per regiment are attached annually to the field artillery for six months, so that there are always at least 80 men per regiment fit to do duty as artillerymen in case of need, and eight men per company carry intrenching tools between them, and have been instructed in throwing up temporary works. The Russian soldier is very handy, most men can use the hatchet (all wooden buildings in Russia are erected with the hatchet alone, without saw or hammer), cook, and sew. All the clothing is made up and fitted in the companies, even to the spinning of the braid. Every soldier, of whatever arm, has four uniforms, all of the same pattern, though of different dates of issue. The recruit receives a complete suit of uniform, known as No. 1; in the second year of his service this becomes No. 2, and is worn on ordinary occasions, No. 1, the new suit, being reserved for high days and festivals. In the third year the oldest suit is known as No. 3, and does for barrack and rough wear, No. 2 being worn on regimental parades, and No. 1 still being in the place of honour. Again each suit rises a number, No. 4 being reserved only for barrack wear, No. 3 for rough work, No. 2 for the town and regimental parades, and No. 1 for Grand Ducal inspections. At the end of the fourth year all that is left of No. 4 becomes the property of the soldier.

You may see, from what I have said above, how independent of the other arms the Russian infantry is; how it contains within itself all it can need; how neither summer suns nor winter snows impair its training; and with what justice does the Tsar pride himself on the efficiency of his foot soldiers.

Cavalry.

The Cavalry of the Russian Army is composed of—

10 regiments of cavalry of the Guard.
18 regiments of Dragoons.
14 regiments of Lancers.
14 regiments of Hussars.

Thus, 56 regiments, with 224 combatant squadrons, are massed into—

2 divisions of cavalry of the Guard,
7 divisions of cavalry of the Line,
1 division of Caucasian Dragoons,

with a numerical strength of about 32,000 combatants, which, however, can be augmented to almost any extent by the incorporation of the irregular cavalry.

At the head of each regiment of the Guard is a Major-General; of the line, a Colonel. Two squadrons form a regimental division, or wing, commanded by a Lieutenant-Colonel.

The regiment of regular Russian cavalry is composed of five squadrons, the first four being combatant, and the fifth, commanded by a Captain selected by the election of his compeers, a depôt squadron, quartered apart from the regiment, in some suitable locality for the supply of horses, charged with the preliminary training of recruits in peace and in war, and the purchase and breaking of remounts. Government haras have lately been established in the steppes of Little Russia, where the luxuriant pasturage provides great facilities for the breeding of horses; but at present the cavalry is largely dependent on private dealers, who come and offer their horses to the Captain of the reserve squadrons.

The difficulty of forming a cavalry soldier being so much greater than that of training an infantry man, cavalry regiments are kept so nearly on their war footing, that a contingent of about 50 men and horses would bring most of them up to their due complement for the field, a system which would, in the event of war, enable the cavalry to be pushed forward to protect the frontier from the very moment of the declaration of hostilities; it will be remembered how great an advantage the Prussians thereby derived on the outbreak of the late campaign.

The Russian squadron is divided into four sections, each commanded by a subaltern, who is responsible to the squadron leader for its due efficiency, as the latter is to the Colonel for the squadron.

The squadron numbers 148 mounted Non-commissioned Officers and men, 44 dismounted Non-commissioned Officers and men, and 7 Officers.

The regimental staff is the same as in the infantry, with the addition of a veterinary surgeon.

From £20 to £27 is about the price paid for remounts. The remounts may be purchased at any age between 4 and 12, but at the termination of the 12th year they must be cast, nor are they taken on the strength of the regiment until rising six; and it is indeed necessary that they should be in the prime of life during army service, for no comfortable stable, nothing but wooden sheds, protect the horses of the Russian cavalry from the wintry blast. Standing on an average about 15·2, with short thick-set legs, they perform prodigies, in spite of the heavy weight they have to carry. Four feeds of corn, hay at morning and night, and water four times per diem, *ad libitum*, keep them in excellent condition; and being admirably groomed, always bedded down with straw, without rack chain or other head-gear besides the halter, with the horse accoutrements hanging at the end of the stall, and the horse's name, age at which purchased, when, and by whom, and the name of the rider, engraved on a bright tin plate over each stall, a visit to a cavalry stable is a most agreeable sight, for the whole of the horses of the squadron are together.

It cannot, however, be denied that influenza, which in its aggravated form turns to typhus, is occasionally epidemic in the winter; but sore backs are totally, I say totally, unknown, and why is this? The saddle, though cumbrous and heavy, never hurts the horse. Four separate folds of soft felt, each $\frac{1}{4}$ inch thick, support a wooden frame previously fitted to the horse's bare back; on the wooden frame is strapped the horse rug, and the saddle is complete. The folds of felt being interchangeable, when one is wet or hardened by dried perspiration, it is turned round or placed on the top of the other, so that a perfectly clean soft material is always next the horse's skin. It is like restuffing a saddle every day. Girth-galls are, too, quite unknown, for one "inch" strap is sufficient to secure the wooden frame and the folds underneath, and one over the blanket and saddle, makes the whole perfectly firm. No martingales or cruppers are used, and the horses tails are allowed almost to touch the ground, to enable them to brush away the flies which torment them in the summer. An improvement is shortly promised in the bridles, but at present they are clumsy and heavy. The men always ride on the curb, except in the manège, when the simple bidoon is frequently used.

From the horses we must now pass to the men they have to carry. Of considerable stature, they have not been selected as light weights, nor are their accoutrements designed to ease the horse's back; and it is somewhat astonishing to find a hussar mounted and equipped with his saddle, appointments, forage, and provision for three days, weighing over 25 stone (360 lbs.), when we are told that speed is nowadays the first qualification for cavalry.

In point of armament the Russian cavalry is somewhat behind the age, although, as in the other branches of the Service, speedy reform is promised. A curved sabre, a pistol issued in 1839, and which no one would dare fire, and a lance for the front rank men of all regiments, hussars and cuirassiers included—even in lancer regiments the front rank only of each squadron is provided with lances—complete the weapons possessed by the Russian cavalry men. A Berdan carbine and a revolver for each man are, however, spoken of.

In personal equipment the Russian cavalry soldier differs but little from other Continental troops, boots and pantaloons being almost universal.

As to drill I am incompetent to speak besides that the cavalry move in threes, and that the riding-school drill is exactly the same as our own; but manœuvres, squadron against squadron, division against division, and regiments against regiments, besides much practice in outpost and vedette duty are carried on throughout the summer months. As to smartness, I saw a squadron of Lancers, with every man in full marching order, every horse saddled and bridled, ready in 6½ minutes from the time the Commanding Officer entered the stable quite unexpectedly, found the men lounging about and gave the alarm.

The men ride well as a rule, but the Grand Duke Nicholas, Inspector-General of Cavalry, is constantly endeavouring to improve the equestrian talent of the Officers. At the Grand Ducal inspections, every Officer, Non-Commissioned Officer and man, passes singly before His Imperial Highness, and there are but few defects even in individuals that are not discovered.

I cannot omit to mention one point about the Russian cavalry, which is peculiar to them, and which might avail them much in the field; I mean the dragoons, who are simply mounted infantry. When it is desirable for them to act on foot, one man in three is left to hold two horses, and then unencumbered by spurs or dangling swords, but armed with rifles, they perform infantry work with the greatest efficiency. The command of the horse detachment is entrusted to the senior subaltern, who has orders to keep as far as possible under cover, yet to keep as near as possible to the dragoons acting on foot, in order that the words "to horse" may be almost immediately put into execution, in order to charge disheartened infantry, to meet cavalry face to face, or to retire swiftly before superior numbers.

Artillery.

The artillery is the arm of the Service on which many Russian Officers specially pride themselves. Were I an artilleryman I might possibly be able to say why with greater exactitude; however, I will let you judge for yourselves.

The Russian artillery consists of—

3 Brigades of field artillery of the Guard.
4 Brigades of Grenadier field artillery.
43 Brigades of Army field artillery.
1 Brigade of horse artillery of the Guard.
7 Brigades of Army horse artillery; or,
48 Rifled 9-pounder batteries.
105 Rifled 4-pounder batteries.
2 3-pounder mountain batteries.

50 Batteries of mitrailleuses.
18 Rifled 4-pounder batteries for horse artillery;
i.e., 1,400 cannon and 400 mitrailleuses.

Each field brigade of artillery is composed of two 4-pounder and one 9-pounder battery of eight guns each, in all twenty-four guns, and is attached to a division of infantry, thus giving two guns per 1,000 men; a number deemed very insufficient for a European campaign. It is therefore in contemplation to add another battery to each brigade, but whether this battery shall be of mitrailleuses is not yet decided. A brigade of horse artillery is attached to each division of cavalry in the field.

As in the battalion of infantry, there are various scales for the strength of a battery, viz.:—

(*a.*) The war establishment, when all the guns and ammunition carts are horsed, and the complement of men for five sub-divisions of which the fifth is held in reserve, is complete.

(*b.*) The augmented peace establishment, when all the guns, but only eight ammunition carts per battery are horsed, and there are but sufficient men for four sub-divisions.

(*c.*) The peace establishment, when but four guns and two ammunition carts (or four in the Guard) per battery are horsed. The four sub-divisions are kept up, but consist of fewer men.

The strength of a 4-pounder field battery on the war establishment is—

6	Officers.
255	Non-commissioned Officers and men.
160	Horses.
16	Ammunition carts, two to each gun.
2	Baggage waggons.
4	Waggons, artillery park, including a field forge.
1	Ambulance.

The 9-pounder battery has an addition of 61 men, 54 horses, 8 ammunition carts, and 1 park waggon.

The horse artillery 4-pounder battery has—

7	Officers.
330	Men.
324	Horses.
16	Ammunition carts, 2 baggage, 4 park, 1 ambulance, and 1 spare waggon.

Every battery has eight guns, and is divided into two divisions and four sub-divisions; and although the guns are nominally 9- and 4-pounders, they throw a considerably heavier projectile than guns of the same nominal calibre in other services. But still the Russians possess no field-piece capable of coping with our new 16-pounder. The Russian cannon are bronze breech-loaders.* Although they in no way deny the superiority of steel for gun metal, they retain bronze, as they are able to manufacture and repair the guns made of it in their own arsenals, whereas they would be almost entirely dependent on Krupp's factory in Prussia if they adopted steel. I believe, however, that one factory of steel guns for heavy ordnance has been established.

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* There are some steel field artillery guns in store, but they will only be issued in the event of war. Their number is not publicly known, but it is believed to be about 400.

Their retention, too, of the breech-loading system for field artillery is explained by the use of bronze guns, even if the oft-quoted expression that *Prussia* has breech-loading cannon, therefore that system must be the best, did not offer sufficient reason, for the irregularities of the bore after the bronze gun is heated, put serious difficulties in the way of muzzle-loading, added to the increase of windage. The bronze gun is but ill to be depended upon after from one to two hundred rounds, when it usually has to be returned to the arsenal to be re-cast.

I spoke just now of ammunition-carts. I said "carts" advisedly, instead of waggons, for the ammunition of the Russian artillery is carried in two-wheel carts, drawn by three horses abreast, the driver riding the near horse—a system entirely peculiar to Russia. So many disadvantages attend these caissons that I can but think that they must more than counterbalance the advantages, if any indeed exist besides the smaller space they occupy on the line of march; a wheel coming off, or the centre horse, who is in the shafts, falling, and the disaster must be complete; and not least of all, the driver must be a man of extraordinary muscle if he can control three horses, and two in one hand, with plain bidoon bits. The result frequently is that when the battery is brought suddenly into action, the three horses of the caisson are seen galloping beyond control in a contrary direction, with their precious load behind them. The body of the ammunition cart consists of a box, about 4 feet by 3, and 2 deep, divided into compartments, each holding, in the case of the 9-pounders, 34 rounds, and, as three belong to each gun, and 18 rounds (16 common shells, and 2 mitraille) are in the gun-limber, 120 rounds are available, or 130 in the case of the 4-pounder field or horse artillery gun.

As the lid of the caisson can only be opened as a whole, and it is necessary to use some exertion to open it, the delay must be serious in getting the ammunition out, if it be opened each time; yet if left open the remaining rounds would get wet if in bad weather. In the field, a spade, pick, and six fascines are carried behind each caisson, to throw up a hasty revetment or make a wide ditch passable.

With the artillery park or reserve are further conveyed—

180 rounds for each 9 pounder.
170 ,, ,, 4 ,,
60 ,, ,, Infantry rifle.
20 ,, ,, Dragoon ,,
10 ,, ,, pistol and barrack rifle.

These are so packed that the supply for a regiment, battery, or squadron can be instantly taken out and sent to the front.

As regards manœuvring, I am incompetent to speak, but I may say that I saw a battery of Horse Artillery drilling admirably on ground so slippery that a man could hardly keep his legs.

The harness of the artillery is not of the finest workmanship. The collars and pads are heavy and clumsy, and the rope traces so inconveniently long, that when a gun is suddenly halted, or is going down hill, they very frequently trail upon the ground and get entangled in the horses' feet. A complete set of new harness for the whole battery is always kept in store to be taken into wear when ordered on service.

I must now devote a few words to the mitrailleuses, of which there are 400 (200 more are ordered) in 50 batteries of eight pieces in the Russian service. The system is the Gatling 10-barrel, somewhat improved in the breech-mechanism by General Gorloff's (the Russian military attaché at Washington) introduction of a screw, worked by a handle, which slowly moves the breech during discharge, about six inches each way. The muzzle, of course, moves in the contrary direction, and thus the lateral range is considerably extended, and, it is asserted, is capable of covering the front of a company of infantry.

The Russian mitrailleuses were ordered in a panic after the outbreak of the Franco-Prussian war; and so great was the enthusiasm when they arrived at St. Petersburgh, that processions of welcome were organized by ecstatic ladies. Yet, now that calmer moments have succeeded to the startling events of that year, the suitability of mitrailleuses for the field is being seriously considered. The younger school of Officers support them loudly, but the older men hesitate in giving a decided opinion; yet most of them think that the *morale* of an army would be greatly impaired if unprovided with them, if placed in situations eminently adapted for their employment. One of the most difficult questions is, how shall the mitrailleuses be employed. Regimentally; a battery attached to each brigade of artillery; or massed in the artillery reserve to be employed in action at the discretion of the Commander of the artillery? This will be decided this summer, when most important experiments will be made. However, the proposition of allotting two or three pieces to each regiment of infantry has been already negatived, on account of the immense danger they would incur of being captured by a mere handful of horsemen.

The eight pieces of a mitrailleuse battery are each provided with 6,290 cartridges in 262 cases, carried in one ammunition cart. The mitrailleuse cartridge and the cartridge of the new Berdan rifle are interchangeable; a most useful provision in case the supply of either one or the other should run short.

Engineers, Irregular Troops, and Conclusion.

The engineers of the Russian service are still under the leadership of the man whose skill and bravery are as much honoured and respected in foreign countries as in his own—Todleben. Under his direction, old fortresses have been modernised, new fortresses have been built, strong works erected to prevent the new railways from being suddenly seized by a foreign foe; but despite the Polish quadrilateral, the guns of Kieff and Nicolaieff, the Russian engineers, aided by the swarms of infantry soldiers and civilians who are employed to help them, have not arrived at the time to rest from their labours.

There are 11 field Engineer battalions, each of four companies, with 5 Officers, 259 Non-commissioned Officers and men, 2 field, 2 siege, and

6 field telegraph parks. The battalion on the war strength numbers 900 rank and file, and on the peace establishment 600, of both of which, half are sappers and the other half miners.

The Pontoon Train is organised in half battalions, of two companies each. Each half battalion has 26 pontoons and 240 men, of whom half are drivers and the other half pontoniers. On the peace establishment but 60 drivers are retained. In the Russian service there are 312 pontoons.

The Irregular troops form the only branch of the Russian service which we have not yet considered. They consist of infantry, cavalry, and horse-artillery, but the majority belong to one of the two mounted arms—Cossacks of the Don, those tall powerful men on small, lean, hardy, ponies, which they guide with the thinnest of snaffle-bits and single reins, armed with long lance without a pennon, short sword, pistol stuck in the girdle, and rifle in leathern case slung behind, who, creeping silently yet swiftly on to an enemy, are ubiquitous in the field—their ponies' heads almost sniffing the ground—and have become the terror of many a foe of Holy Russia. Their dress is most picturesque. They use no spurs (except in the escort of the Emperor), but have a small lash whip slung on their wrists. They ride admirably, yet with stirrups so short that in winter, when riding in overcoats, and nothing but the calf of the leg is seen, one wonders where they have managed to stow the thigh. Members of a manly race, all of whom are soldiers, associated with, trained to arms, and accustomed to horses from their earliest infancy, always left to shift for themselves, never nurtured in luxury or comfort, these Cossacks of the Don are invaluable troops for escort, police, outpost, foraging, and scouring duty; yet their deficiency in education would probably prevent their performing European cavalry service with the same intelligence as the Prussians did in the late campaign. Their nominal number is 65,000, with 232 guns, yet this might be increased to almost any extent in case of need, for not a man in those provinces but is ready with horse and arms instantly to march to death for his Tsar. They are organised in regiments (polks) of six "hundreds" (sotnias), of which but a few are quartered in time of peace for escort duty in the principal Government towns. These are relieved every three years. During the Crimean war 84 regiments were raised.

But now, having already trespassed too long on your indulgence, I will add but a few words more. I say a few words more, for surely any lecture or paper (whatever you are pleased to term my humble effort,) on "the Russian Army" would be incomplete without a brief reference to those rumours that Russia is about to seek to disturb the peace of Europe, which are constantly taking possession of troubled and imaginative minds. It is not uncommon to be assured by people who expect a storm to gather from every cloud not bigger than even the *little* finger of a man's hand, that the Imperial houses of Romanoff and Hohenzollern are about to league together to wipe the Hapsburgs from the face of the earth, or that the inhabitants of Vienna and Petersburgh will shortly be striving to read the public telegrams from the seat of war, or that the Muscovite hosts are making ready to punish the Teuton armies for their victories on the plains of France, or that each day detracts from the safety of our Indian Empire through Russian aggression. But do these alarmists study the situation? Do they not see that the armies of the Tsar, although numerous, are far from being ready to take the field? that, deficient of the complement of Officers, in the midst of re-arming, and inaugurating a new military organization, with yet imperfect and ill-secured communications, with an empire already too large, and the frontier line which divides it on the west from mighty and intolerant neighbours, but ill defended, with an infantile commerce, promising though it be, utterly unable to stand the rude shock of war, the Cabinet of the Emperor Alexander will do all it can for some time to come to avoid any issue at arms, and will rather entertain measures of internal reform than of territorial aggrandizement, even though it be to secure what is essential to the proper development of Russian commerce, the undisturbed exit of the Black Sea, by establishing Russian dominion at Constantinople, the naturally ruling idea of every loyal subject of the Tsar?

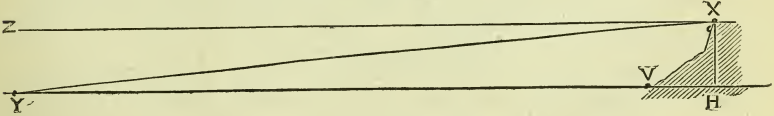
I will now conclude, apologising for the length of time I have kept you, and with the hearty expression of my thanks for the honour you have done me in coming here this day, and for the attention with which you have been pleased to listen to me. To the best of my belief, I have told you plain unvarnished facts. If there be aught in the Russian service worthy of introduction into our incomparably administered Army, you, Sir William Codrington and Gentlemen, are the best judges. I trust, however, that I have succeeded in showing you what a noble army Russia possesses, but that in improving and reorganizing it, she is but acting up to that first article of the political faith of most great Powers, including ourselves, who, however, occasionally doubt its truth, and place the negation before the second verb—"*Si vis pacem para bellum.*"

CAMPBELL'S RANGE INDICATOR.

A Paper contributed by Captain John R. Campbell, Hants Militia Artillery.

Next to efficient ordnance for the defence of our coasts, few things are more important than a good "range-finder," or (speaking in more general terms), some easy, rapid, and at the same time *sufficiently exact* method of ascertaining the distance between our guns and the enemy's ship. Nothing can be more unsatisfactory than the common process of searching this out by means of *trial shots*, as they are called, that is, by judging the distance by the eye for the first round, and correcting the elevation given to each of the following rounds by the *apparent* error as shown by the graze of the one before, until at last we hit. Against a ship in motion this system is almost absurd; one might frequently go on bungling until she was out of all range, or, worse than that, until her crew by a well-directed fire had succeeded in dismounting our most powerful gun. It must be remembered, too, that each round with the present gigantic weapons occupies several minutes and involves the cost of a very expensive projectile, besides the wear-and-tear of the gun. Yet, curiously enough, until very recently the question of "range-finders" was hardly dreamt of; at any rate it never seems to have seriously engaged the attention of our scientific military departments. Now there are several plans before the notice of the War authorities, and before many years, no doubt other new ones will appear, or improvements on the present instruments be suggested.*

It is not my intention to offer any opinion regarding the respective merits of the different range-finders we have heard of lately; indeed, I do not feel myself competent to attempt such a task were I inclined to do so. The object of the present paper is simply to describe my own designs for an instrument of this sort, suitable for coast batteries, involving very little expense, simple of application, and which will indicate with *considerable* accuracy the range of a vessel under way—not as the result of a single observation, but by a continuous process, showing it for every point of her course.



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* See a paper by the author entitled "Calculation of Range for the service of Artillery," in vol. viii, page 431, of the Journal. (In that article at page 434, lines 15 and 16 from the top, the sign − ought to be + in the first fraction, and the + in the second ought to be −).

Suppose X to be the highest point on the works of a battery overlooking the sea, from which observations can conveniently be made, YH the water level at any particular height of tide, and Y the position of an enemy's ship. Join XY and draw XZ and ZH, horizontal and vertical lines, through X.

Now I assume the height HX of a flat stone at X, on which (during the time the battery is in action) the instrument stands, above the sea-level, to be always known to a yard. The height of tide is easily shown by a rough scale painted on some post, pier, or rock at the point V, or in the immediate neighbourhood of the fort; besides which, in *critical* times, a register of tides might be kept. Call this known height h; put angle ZXY (which is = angle HYX) = θ and XY (the range) = R.

$$\text{Then we have } R = h \text{ cosecant } \theta$$

an equation giving us the proper value of R for any particular one of θ.

Now the object of my range-indicator is to measure this angle θ—let us call it the *angle of dip*—recording the result, not in degrees and minutes, but in yards of range corresponding to the height of tide at the time of observation. This is effected by the motion of a telescope mounted theodolite fashion, the range answering to any position of its axis below a horizontal line being read off on a high multiple of the arc described by the extremity of its axis. The telescope, by means of a toothed arc gearing with an endless screw (or in large instruments it may be a pinion) gives motion to a circular disc, causing it to make one exact revolution while it moves through an angle of dip of 3 degrees—for very few coast batteries are more required, but the principle is the same whatever limit we assign to θ. On the surface of this disc the range is shown in a manner I shall presently describe.

Fig. 1 (*see* plate) is a side elevation of the arrangement, and Fig. 2 a plan. The framing (brass) mainly consists of two inverted V-shaped cheeks, AA (in the elevation) being one of them, between which the telescope, T, is supported in plummer-blocks, *t*. These cheeks are erected on a circular plate, E, which rests and is pivoted on another plate F, the latter being in a piece with the triangular base or pedestal. For the sake of portability, the upper part of the instrument can be lifted out of the socket formed in the base. L is a spirit-level carried on the revolving plate E, and *w*, *w*, *w*, three levelling screws by means of which the instrument is brought into adjustment. The telescope—a powerful one about 16 inches in length and furnished with the usual cross-wires—has attached to its side a short toothed arc R, whose centre is at *t*, in gear with the endless screw S, the shaft of which is borne on a projecting branch, BB, of the cheek AA. On this shaft is fixed a circular disc of zinc, D, 2 feet in diameter, and the radius (6 inches) and pitch of tooth of the arc are such that D makes exactly one revolution for a motion of the telescope (from the horizontal position) through 3 degrees. The manner of mounting the screw with its disc is shown more plainly in Fig. 3, which is an end elevation of this part of the arrangement drawn to twice the scale used in the other figures. The same letters, however, refer to the same parts in all. S is the screw passing through a plummer-block, *p*; *v* a boss on its shaft to keep it in position, while the lower end rests on a screw, *e*, held in a small step, *q*, by means of which it is prevented from working loose. Both plummer-block and step are fixed to a plate, PP, and this is clamped by three bolts to another plate forming part of the projection BB. The bolts pass through short horizontal slots in the latter plate to allow of a small amount of primary adjustment by the maker before it leaves his hands. The toothed arc, R, is similarly clamped to a piece, *f*, projecting from the side of the telescope. The disc rests on a circular table *a* (virtually forming a portion of the screw shaft), and is secured in its proper position by a bolt, *b*, with a capstan-headed nut below. This bolt passes through a hole in the table and a slot in the disc, thus permitting of the latter's adjustment.* K*k* (best seen in Fig. 2) is a fixed scale, formed of a strip of cardboard and held in position by having its end clamped between two plates, M (the upper one being hinged on to the lower, and the whole secured by a screw passing through a hole in the strip). The plates, M, are carried on a branch, C, of the framing, and in order to stiffen the arrangement there is a bar, C′, connecting the two ends of the instrument, and supporting a plate, *m*, over which a portion of the disc (liable to be pressed down by the fingers of the operator) passes. Screwed into the disc, and projecting below it, is a movable stop, *g*; this, by coming in contact with the bar, limits the motion of the disc to somewhat less than a complete revolution, thus preventing the screw, S, from running out of gear with the toothed arc.

I now come to an important feature of the apparatus, viz., the surface of the disc. This is painted white, or coated with paper, and has a curve described on it in the following manner. A large number of radii are drawn, and on each, measured from *d*, the centre, is marked off (to a convenient scale) the range the instrument placed at a certain height, *h*, ought to indicate, supposing that radius brought into a position coinciding with the edge, *k k*, of the fixed scale, which itself is in line with *d*. Practically, it is easiest to begin by dividing the surface of the disc into 36 angular parts, each of which will correspond to 5 minutes of dip. A number of points, 1 . 2 . 3 . . . *r*, will thus be obtained lying in a spiral curve. This curve is then carefully traced by a black or red line, the radii, except that marked *d* Z, which corresponding to $\theta = o$, and $\theta = 3°$, being afterwards obliterated. The disc is in its proper position on the screw shaft when this *zero* radius is found to coincide with the edge of the scale, the axis of the telescope having first (by means of the spirit level, L′) been rendered horizontal.

It will be easily seen that the polar equation to the curve is—

$$R' = h \text{ cosecant } \frac{\theta'}{120}$$

where *d* is the pole, R′ the radius vector, and θ' the angle Z *d r*. *d* Z produced is an asymptote to the curve.

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* An opening is formed in the plate, P, in order that the position of the toothed arc may be regulated without dismounting the screw. In all the figures some minor details—small screws, &c.—are omitted.

Supposing now the divisions on the scale *k k* to correspond with the unit of measure employed in describing the curve, it is evident that as the disc revolves during a change of position of the vessel on whose water-line the axis of the telescope is directed, a *near approximation* to her range will constantly be shown on the scale at *r*, the point of intersection of its edge, *k k*, with the curve. In Fig. 2 the instrument is arranged for a height of 20 yards, and the ultimate divisions, or *units*,* of the scale may correspond to distances in the range of 20 yards each. The same curve will, however, serve for *any* height (between very considerable limits) simply by changing the fixed scale; for since, supposing θ to be constant, the range is proportional to h, we have only to make the unit of division inversely proportional to the height—taking any scale already constructed for a known height as a *datum* for our new one—and the result is obtained. Thus, having a scale as in Fig. 2, correct for 20 yards, if we wish to apply the same curve to a position 27 yards above sea level, we must make the divisions in our new scale $\frac{20}{27}$ times the length of those (signifying the same quantity of range) in the other. A scale can be marked out by any artillery Officer in less than an hour. The process, a very simple one, is this. An old scale, *k k* (Fig. 4) being its edge, is pinned on to a drawing board, and the position, *d*, of its zero found. A slip of cardboard for the new scale is then attached to the board, with its edge, $k'\ k'$, in line with *d* and making any angle $k'\,d\,k$ with *k k*. Suppose the old scale is for a height h and we require the new one for h', any two distances, $d\,x$, $d\,y$, are marked off on the edges of the old and new scales respectively, such that—

$$d\,x : d\,y :: h' : h$$

Then, joining $x\,y$, and through the divisions of *k k*, drawing lines parallel to $x\,y$, these lines evidently divide the edge $k'\,k'$ in the manner required, *i.e.*, into a scale correct for the height, h'; *d* will be the zero, and the same figures must be attached to the divisions as those found opposite the divisions on *k k*, from which they are severally derived.

Every fort ought to possess five or more scales referring to as many different heights of tide, since an error of a yard or two in h produces a considerable one in the observation of a long range, or indeed of a comparatively short one if measured from a low position. For distances over 3,000 yards it is as well to add 1 yard, and for the less common ones, exceeding 4,500 yards, 2 yards, to h in constituting scales, to allow (roughly) for the curvature of the earth.

In order to find a scale suitable to the tide level at any particular time, it is not always necessary to consult any measure marked on a post or pier—a buoy, or half sunken rock, the exact distance of which is known, will answer the same purpose; for, having directed the axis of the telescope to the water line on this object, we have merely to choose that scale which gives this distance correctly.

Fig. 5 is a plan of the "range-indicator" under a slightly different form, but one that, simple as it at first sight appears, I consider inferior in more than one respect to the arrangement I have described. Here the disc, instead of having a curve described on its surface, is divided by radii into angular spaces corresponding to every so many minutes of dip—one minute for the long ranges, two or three for the short. On each radius is written the range for several heights of tide the instrument ought to show when that radius is in line with a fixed pointer, I, clasped in a socket, M. The socket is supported on a branch of the framing in the same position as the plates M in Fig. 1, and the pointer, which can be advanced or drawn back, is clamped by a thumb-screw. The number of yards for different tide levels are arranged in zones; a few only are inserted in the figure. *d* Z is the zero radius. Of course an instrument on this plan must have its disc specially constructed for the height of fort above mean tide where it is applied. A plan of the parts below the disc, common to both forms of indicator, is shown in this figure by dotted lines.

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* These divisions are too minute to be inserted in the figure.

In using the "range-indicator," it is best to employ two Non-commissioned Officers, although one will do. The duty of the first is to keep the intersection of the cross wires constantly on the lowest visible point of the object under fire, elevating or depressing the telescope by turning the disc; he also reports on the effect of shots. That of the second is to read off the range, and call it out (as often as it appears to change) to the Officer who is directing the firing.

The merits I venture to claim for the instrument are three, the first, however, only applying to the form with a curve on the disc:—

1st. The same instrument is applicable to all (or nearly all) heights, simply by using different scales.

2nd. The working of it requires no technical education, any intelligent gunner may be taught the use of it in an hour.

3rd. The range is *constantly* known (to a sufficient degree of accuracy), no matter how frequently or how rapidly it may vary; in fact, with this arrangement no time is lost by observations independent of one another, which, from the time they require, are often in the case of a moving ship, valueless before their results can be applied.*

I believe such an instrument might occasionally be useful for other purposes besides that of range finding, by the addition of a compass, H, mounted on the parallel plate E. This gives us the power of setting the cross wires on any point out at sea of which we know the direction and distance, and thus we are enabled to *watch* the position of a sunken torpedo.

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* This range indicator appears to me especially applicable to forts surrounded by water, like those now building at Spithead, where, owing to the smallness of area, no trigonometrical measurement of range from a *horizontal* base is practicable.

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(Double Number).

Evening Meeting.

Monday, March 18th, 1872.

ADMIRAL THE RIGHT HON. THOMAS, EARL OF LAUDERDALE, K.C.B., in the Chair.

NAMES OF MEMBERS who joined the Institution between the 5th and 18th March, 1872.

LIFE.

Suffield, Right Hon. Lord, Lt.-Col. Norfolk Art. Mil.
Hoole, F. W., Lieut. 2nd West York Rifle Vols.
Lumsden, Henry, Capt. London Scottish Rifle Vols.

ANNUAL.

Grace, Sheffield, Major h.-p. 86th Regt.
Evans, R. Harding, Capt. Royal London Militia.
Greenwood, Frederick, Lt.-Col. 6th West York Rifle Vols.
Coles, Alfred, Lt.-Col. 1st Surrey Rifle Vols.
Oxley, John S., Lt.-Col. 19th Middlesex Rifle Vols.
Read, Philip, Captain 19th Middlesex Rifle Vols.
Pearson, M. B., Captain 2nd Middlesex Art. Vols.
Adair, A. S., Captain Edm. Royal Rifles.
Milne, H., Maj.-Gen. Bengal Army.
Conolly, Arthur, Lieut., Bengal Staff Corps.
Forster, William, Lieut. 60th Rifles.
Clery, C. F., Captain 32nd Regt.
Hay, W. E., Major, late Indian Army.
Tully, Thomas, Lieut. 28th Middlesex Rifle Vols.
Lloyd, N. Y., Lieut. 82nd Regt.
Read, C. E., Lieut. R.N.
Boileau, C. H., Captain 61st Regt.
Hunt, Chas. B., Lieut. 4th Surrey Rifle Vols.
Puckle, Alfred D., Lieut. London Scottish Rifle Vols.
Feilden, R. J., Col. late 60th Royal Rifles.
Hilton, J. W. D., Lieut. 3rd Hussars.
Hannen, G. G., Captain R.A.

ON ECONOMY OF FUEL IN SHIPS OF WAR.

By T. SYMES PRIDEAUX, Esq., C.E.

It has always appeared to me that the question of "Economy of Fuel in Steam Ships of War" has never received that amount of attention to which the importance of the subject entitles it. All those considerations which render it so desirable to obtain steam power on land for our manufacturing and other purposes, with the smallest possible expenditure of fuel, are increased in force and heightened in importance when applied to the case of ships which traverse the ocean. Economy of fuel in a ship of war confers the power of selecting one or more from a list of many advantages. It is equivalent to a smaller, handier, and cheaper ship, or to thicker armour and heavier armament, or to higher speed, or lastly, but not least in value, to the capacity for remaining under steam for a longer period.

Supposing two rival powers with navies of equal force, but that the ships composing the Navy of one were able to maintain their stations at sea without resorting to a coaling depôt twice as long as those of the other, who can fail to recognise in this faculty an element of superiority that would, in the event of war, find ever-recurring opportunities of exhibiting itself?

Imagine two ironclads of the largest size and armament, costing say £300,000 each, and having stowage in their coal bunkers for 800 tons of coal, and that this quantity amounts, in the case of one, to eight days' consumption, and in that of the other to sixteen, who can fail to recognise in the latter, such a much greater capacity for doing duty as a ship of war, that almost any sum would be well expended on the former, to obtain the same economy of fuel? Were it requisite to construct her furnace bars and doors of silver to effect this object, the price should be cheerfully paid. Unfortunately, it must be confessed that our own Navy is sadly behindhand in this element of efficiency.

The comparison I have made of two sister ships, one of which burns only half as many coals as the other, is, I believe, by no means an exaggerated picture of the diminished consumption of coal per horse-power in steam vessels, which has actually taken place since my attention was first directed to this subject twenty years ago. At that period I pointed out that the consumption of coal in marine engines was excessive, and capable of being reduced one-half; but my statements on that head proved unpalatable, and found little credence amongst the engineering authorities of the day. I have lived, however, to see them verified, and also to come to the conclusion that they were so much within the mark as to be capable of being repeated, or in other words, that our consumption of coal per horse-power in marine engines may again be halved.

As long ago as 1854, at almost my first interview with Sir Baldwin Walker, who was then Comptroller of the Navy, I stated that Her Majesty's ships were burning twice the weight of coal per h.-p. that would be used in a not very distant future, that all the knowledge was in existence to enable this saving to be effected, and that it ought to be applied at once. I have since had the satisfaction of sending Sir Baldwin an extract from the Naval Correspondent of the *Times*, showing that the economy predicted had been more than attained, and I was able to append a reference, with the motto, *Litera scripta manet*, showing that the result had been effected by the precise channel pointed out by me in my treatise on Economy of Fuel, published in 1853. In 1855, after my return from the Baltic, I was so impressed with the waste of fuel and the inordinate heat of the stoke-holes I witnessed in the fleet—the candles being melted in the Officers' cabins in the gunboats—that I addressed a letter to the Admiralty offering to reduce the average consumption of fuel one-half, and the temperature in the stoke-holes 20°, but the offer was so distasteful to the Engineering Department, that they did not even vouchsafe a reply.

In 1857 I also offered, for the third time, to save 50 per cent. in the fuel expended per horse-power obtained, saying, " I state with confidence " that this amount of saving may be effected by the channels I have " indicated. In short, the question really at issue is whether a waste of " 50 per cent. of fuel is to be persisted in, for the sake of the personal " interests and feelings bound up with the present arrangements."

In January, 1859, I submitted a memorandum to the Admiralty, from which I subjoin the following extract:—" For five years past I " been labouring, in season and out of season, to inculcate the importance—nay, the absolute necessity—of allowing a proper *flame-space* " (large enough for the most bituminous fuel likely to be used) between " the grate bars and the tubes, if anything approaching perfect combustion with its concomitant absence of smoke is to be attained. In " tubular boilers as they have been, and I fear I must say still are, " commonly constructed, the flame arising from the last foot or two feet " of bars, is extinguished by entering the tubes before its development " is complete, producing smoke instead of heat. The necessity of preserving the products of combustion from contact with metallic " surfaces till after inflammation is complete, to obtain perfect combustion appears to me most obvious, yet it has been all but entirely " overlooked in the construction of boilers up to the present time—the " existing boilers in the Navy to wit."

The researches of the celebrated French chemist Regnault, have given us a far more accurate knowledge of the laws governing the amount of heat in steam of different elasticities and temperatures, than was possessed in the the time of Watt, so much so, that within very narrow limits of error, we may now be said to possess the necessary data for treating exhaustively the question of the steam power practically attainable by the combustion of a given weight of fuel.

The question of the economic production of steam-power naturally resolves itself into two perfectly distinct branches, viz., first, how to evaporate the greatest weight of water with a given weight of combustible, hinging on the structural arrangements and management of the furnace and boiler; and secondly, how to obtain the maximum mechanical effect from the steam raised, dependent upon the construction and management of the engine. The first branch being chiefly concerned with chemistry and physics, the second with physics and mechanics.

To evaporate the greatest weight of water from the fuel employed involves two considerations:—First, the generating from that fuel the utmost amount of heat it is capable of rendering, to be accomplished by effecting perfect combustion in the furnace. Secondly, the transference of the largest practicable proportion of this heat to the water in the boiler, to be attained by the judicious arrangement of its heating surface. The first, a question beset with complication; the second, one of comparative simplicity.

Coal is so much more extensively used than any other combustible for the production of steam power, that in so condensed an exposition of the subject as the present must necessarily be, it will be most profitable to restrict our remarks to its use.

At the outset of our enquiry we are confronted with the question, What proportion of the whole heat coal is capable of yielding, do we succeed in utilising in raising steam, or, in other words, transferring to the water in the boiler?

After carefully investigating the subject, the conclusion at which I have arrived is, that we cannot assign to carbon a smaller heating power than 9000° centigrade, which is equivalent to the capacity for evaporating fifteen times its own weight of water from 100° Fahrenheit. The average duty obtained in marine boilers at present must, I apprehend, be set down at not more than 7½ lbs. of water evaporated by 1 lb. of coal, or, in other words, we only obtain half the duty which theory assigns to the fuel. Let us console ourselves for so humiliating a result by the reflection, that this very large margin for waste is as encouraging to our future prospects as it is discreditable to our present practice.

The heat obtained from coal is evolved by the chemical union of the hydrogen and carbon of the coal with the oxygen of the atmosphere, forming with the former substance, water, and with the latter, carbonic acid, and just in proportion to the exactitude with which we transform all the hydrogen of the combustible into water, and all its carbon into carbonic acid, without *admitting any superfluous air*, will be the temperature produced, and (other conditions being equal) the amount of water evaporated.

Different coals vary in their component parts, and in the proportion of these to each other. Carbon and hydrogen, however, are the essential constituents of all as far as their heating capacities are concerned, and I shall assume as a convenient standard that 100 parts of coal consist of 80 parts of carbon and 5 of hydrogen, leaving out of view the other elementary substances which enter into their composition (consisting of oxygen, nitrogen, sulphur, and incombustible ashes, composed principally of sand and clay), as non-essential to the subject under discussion. There is a convenience in assuming these proportions of 80 carbon and 5 hydrogen for the composition of coal, for since hydrogen furnishes, weight for weight, four times as much heat as carbon, the 5 parts of hydrogen will furnish 20 per cent. of the whole heat, and the 80 parts of carbon 80 per cent., being the same proportionate part of the heat as it forms by weight of the fuel, and thus the heating power of coal, as a whole, may be treated as equivalent to an equal weight of carbon.

The hydrogen in coal exists in chemical combination with carbon, and when heated without the access of air, passes off with the carbon, with which it is combined in the gaseous form as carburetted hydrogen, a gas consisting of 1 part by weight of hydrogen and 3 of carbon, being in fact the coal gas we use for illuminating purposes. 100 lbs., therefore, of coal containing 5 parts of hydrogen and 80 parts of carbon in the 100 lbs. would yield 20 lbs., or 525 cubic feet of this gas, and 65 lbs. of solid carbon, or coke.

As the 5 parts of hydrogen in coal gas furnish 20 parts of the total heat of the coal, and the 15 parts of carbon 15 parts, the two combined contain 35 per cent. of the total heating power of the combustible. But here I must not omit to draw your attention to the important fact that if, through the defective regulation of the air supply of the furnace, you cause half this gas to pass off up the chimney unburnt, the heat wasted is more than 17½ per cent., because the gas has robbed the furnace of the heat employed in its own volatilisation or transformation from the solid into the gaseous form. 7½ per cent. is by no means an over-estimate of the heat subtracted from the duty of the carbon by this process, and hence we arrive at the result that, in the case of a furnace so managed as to dissipate half the carburetted hydrogen unburnt, the waste of fuel through this channel alone reaches 25 per cent. That this amount of waste does in practice often take place from this cause is unquestionable, since I have in numerous instances witnessed this percentage of saving effected by simply altering the conditions governing the air-supply of the furnace during the first five minutes after coaling, the period at which, under the ordinary system of furnace management, or rather mismanagement, this great waste of unconsumed gas takes place. In short, I have rarely seen an instance where experiment did not prove that, with bituminous or north country coal, a saving of not less than two-thirds of this amount, or from 17 to 18 per cent. was obtainable by these means, so that I feel justified in saying that in furnaces as constructed and fired at present, *i.e.*, with no provision for adapting the air supply to the changing conditions and consequent varying requirements of the fuel, this waste of a large proportion of the gaseous constituents of the coal must be regarded as the normal state of things, and inseparable from the rude, defective, and unintelligent system of furnace-management pursued.

Although, as a general rule, the combustion of the carbon of the fuel is effected without the large proportion of waste attendant upon that of its gaseous constituents, yet occasionally—in such a case, for instance, as one of which we have recently heard, where, in the Southern Pacific, the flames proceeding from the top of the funnel of one of Her Majesty's ships at night were actually mistaken for an eruption from a volcano in one of the peaks of the Andes—a great waste of carbon occurs. Such a state of things as this, however, can only exist with most defective furnace arrangements, involving a really frightful sacrifice of fuel.

I will endeavour to describe the conditions under which alone I consider such an occurrence as described to be possible. The flame emitted does not extend from the furnace through the flues to the funnel head, as many suppose, but is produced by carbonic oxide gas (generated in the furnace through deficiency of the air supply), passing off at such a high temperature as to preserve the temperature necessary for ignition, after mixing with the 2½ volumes of atmospheric air required to furnish the oxygen needful for its transformation into carbonic acid. Now, since an atom of carbon, in combining with one atom of oxygen, and becoming carbonic oxide, only yields one-third of its heating power, the remaining two-thirds being set free upon its combining with the second equivalent of oxygen, and becoming carbonic acid, it follows that two-thirds of the heating power of all the carbon passing off as carbonic oxide is wasted.

Even this statement does not adequately represent the frightful sacrifice of heating power, of which flames passing off at the funnel head are the sign; for small as may be the proportion of the heating power of the fuel developed in the furnace, of this small proportion, an unusually large part is wastefully dissipated into the atmosphere, as is shown by the high temperature of the gases issuing from the funnel, such high temperature being the result of the diminished subtraction of their heat by the surface of the tubes, consequent upon the latter being coated with soot. Unless there be something more than ordinarily faulty, either in the construction of the furnace, or the mode of firing pursued, the coating of the tubes with soot may be regarded as the necessary precedent to the exhibition of flame at the funnel-head, as in fact begetting the conditions under which it occurs. A deposition of soot on the interior of the tubes, simultaneously diminishes the draft, and in a still greater ratio the steam generated. Heavier firing is resorted to to keep up steam, with the effect of aggravating the previously existing evils. Flame makes its appearance at the top of the funnel, and a vicious circle of evil consequences is produced which mutually re-act upon and aggravate each other.

The waste of a large proportion of the coal gas or carburetted hydrogen contained in the fuel, during say the first third, or first five minutes of the coaling interval, which ordinarily takes place under the present system of furnace management, by no means pre-supposes such conditions in the arrangements and working of the furnace, as would subsequently lead to the dissipation of carbon as carbonic oxide. The fatal sign of flame at the funnel head, however,—announcing as it does a thick layer of ignited carbon on the bars, and an insufficient air-supply,—may be accepted as indicative of conditions being present in the furnace, which must have been productive of a more than average waste of carburetted hydrogen at an earlier period.

Great as are the evils which we have been reviewing, proceeding from a deficient air supply, they are rivalled, and, perhaps, having regard to its greater frequency (during the latter portion of the coaling interval), exceeded in amount as a whole, by the opposite fault of too much air entering the furnace. The excess of air acts prejudicially, not by interfering with the perfect combustion of the carbon, none of which under these altered conditions can escape transformation into carbonic acid, but by diluting the temperature of the furnace by the admixture of cold air, which, after receiving a large accession of temperature, passes off through the funnel, robbing the furnace of heat that should have been employed in raising steam. All good firemen are awake to the evil consequences of allowing their fire to burn through at the back, admitting a free ingress of air, or the still more fatal results of perforations in the door or bridge. Let us analyse the conditions under which these evil consequences ensue, and the causes on which they depend:—

One hundred pounds of coal require, in order to obtain the equivalent of oxygen necessary for its perfect combustion (or the transformation of all its hydrogen into water and all its carbon into carbonic acid)

15,000 cubic feet of air, and the temperature resulting may, to speak in round numbers, be set down at 4,200°. No such exact adjustment of the air-supply is possible in working a furnace, and there are reasons why, in practice, a better result is obtained by admitting an increased quantity, say $\frac{1}{3}$rd more than the amount required to furnish the exact combining equivalent of oxygen. Assuming, therefore, the admission of $\frac{1}{3}$rd more, or 20,000 cubic feet, we get a temperature of 3150°, of which, taking the temperature of the gases when they leave the heating surface of the boiler and enter the funnel at 600°, 81 per cent. is absorbed by the heating surface of the boiler, and profitably employed. If instead of 20,000 feet twice the quantity, or 40,000 feet, enter the furnace, we only get a temperature of 1575°; and supposing the temperature of the gases entering the stack to be the same, viz. 600°, we only get 62 per cent. absorbed by the heating surface and performing the duty of raising steam. In reality, however, since twice the volume of gas traverses the flues in the same time, it must pass over the heating surface at twice the velocity. The area of the heating surface therefore becomes halved in proportion to the quantity of gas passing, and, as a consequence, the products of combustion will pass off at a higher temperature, so that in reality less than 62 per cent. will be absorbed.

Thus, paradoxical as at first sight it may appear, when a diminished temperature of the products of combustion is caused by their volume being increased by an excess of cold air entering the furnace, the lower their temperature in the furnace, the higher will be the temperature at which they will pass off through the funnel, still further magnifying the waste of fuel invariably attendant upon the existence of conditions which diminish the temperature by facilitating the entrance of superfluous air.

Our inquiries have landed us at the conclusion, that the more narrowly the conditions attendant upon the working of a furnace are investigated, and the more closely the duty performed is compared with these conditions, the more manifest does it become that the first of the two branches or divisions into which the question of the economic production of steam power naturally resolves itself, viz., "How to evaporate the greatest weight of water with a given weight of combustible?" is for all practical purposes almost synonymous with the question, "How to admit the right quantity of air to the furnace?" A competent heating surface must, as a matter of course, be provided; but it is not in respect to the absorption of heat, but in respect to its generation, that our present practice is so sadly in arrear, and that such a vast scope for improvement is visible.

How are we to realise in practice this all-important and indispensable condition to economic furnace management, the due adjustment of the air-supply, that is, the supply of such a quantity as a *whole*, and so distributed as to *period*, as to convert all the hydrogen of the fuel into water, and all the carbon into carbonic acid, with the admixture of the smallest possible quantity of surplus air? However difficult the task may be, it is nevertheless most certain that by how much we deviate from the correct quantity, either more or less, by so much do we fall short of "generating from the combustible, the utmost amount of heat it is capable of furnishing," for the laws of chemical affinity are unchangeable and ubiquitous. In short, this danger of erring on either side, may be said to be the Scylla and Charybdis to which voyagers in search of perfection in furnace management are exposed, and safety is only to be attained by studying the landmarks and bearings so carefully as to be able to steer with confidence a middle course.

The supply of air which enters a furnace depends upon the ratio existing between the *pull* exerted by its chimney or stack and the *obstruction* caused by the layer of fuel on the grate-bars, and a more or less confined ashpit. The force of the pull, or suction, exerted by the stack, is the difference in weight between the column of heated gas it contains and a similar column of air at the temperature of the atmosphere. The higher the temperature and the taller the stack, the greater the force of the draft, and *vice versâ*. The great practical difficulty which stands in the way of obtaining the regular flow of the right quantity of air into the furnace, is the fact that the demand is not a *constant*, but a *varying*, quantity. Were the same conditions always present in the interior of the furnace, that is to say, the same thickness of fuel on the grate bars, and the various layers of this fuel at similar stages of combustion, so as to cause the supply of air demanded by the wants of the fuel to be uniform, then, the average rarefaction or draft in the stack being once attained, a steady supply would enter the furnace, proportionate to the thickness and closeness of the layer of fuel, the area of the grate-bar openings, and the free ingress of air to the ashpit, which, once adjusted, the equable and economic working of the furnace would be secured. Unfortunately however, for the cause of economy of fuel, the reverse is the case; not only are the requirements of the furnace not uniform, but they fluctuate within very wide limits, whilst the evil results in waste of fuel which ensue, are aggravated by the fact that the furnace's unassisted power of supplying itself, *varies in an inverse ratio* to its requirements, being least when these are greatest.

Assume a coaling interval of 15 minutes, and that towards its end the carburetted hydrogen having passed off, a layer of ignited carbon alone is left on the bars through which the current of air has gradually worn for itself a series of channels or perforations, till their united area is more than sufficient to admit the right quantity of air under the existing amount of draft. Let us then examine the condition of the same furnace a few minutes later, after the act of coaling has taken place, and we shall find a thicker layer of fuel on the bars, the channels for the passage of air which previously existed in the thinner layer, obliterated, and the temperature of the furnace greatly lowered by the abstraction of heat consequent upon the introduction of the charge of cold fuel, and the volatilization of its gas going forward. Thus the diminished temperature in the stack diminishes the draft at the period when the resistance offered by the fuel to the passage of air is greatest, and the demands of the furnace for air is at its highest point, in consequence of the large quantity of oxygen required for the ignition of the carburetted hydrogen gas now in course of rapid evolution. As the necessary sequel to these conditions, the gas generated passes off unburnt, worse than simply wasted, because it has abstracted a portion of heat from the ignited carbon in undergoing transformation into the gaseous form. We here get an explanation of the fact that more heat is practically obtained in some kinds of furnaces from coke, or, in other words, coal deprived of $\frac{1}{3}$rd part by weight of that portion of its combustible matter which is richest in heating material, than from coal in its pure state. From the same cause also, viz., defective furnace management, the commercial value of coal is often in an inverse ratio to the quantity of its bituminous constituents and heat-giving power, were proper means employed to make them practically available.

In short, under the present system of furnace management, the function of the furnace as an agent for raising steam may be said to be almost entirely suspended after each coaling interval, and only gradually regained, the furnace virtually assuming the office of a retort for the manufacture of gas, but with this difference in the result, that the gas which in the latter case is carefully preserved as a valuable commodity, is here despatched unconsumed up the chimney, carrying off at the same time the heat stolen from the carbon in effecting its volatilization.

Can a doubt be entertained of the wisdom and desirability of burning this gas instead of wasting it—of filling the furnace with flame instead of smoke—of causing the generation of steam to proceed with additional rapidity immediately after coaling, instead of being all but suspended?

Now all that is required to evoke this transformation is to supply the gas with ten times its own measure of atmospheric air, and (except in a few exceptional cases of badly constructed furnaces) it will require no further solicitation to burst into flame. Why is this not universally done? A curious chapter of human error is unfolded by the answer. When apertures of the necessary size to admit the requisite supply of air were arranged to open into the furnace above the fuel, notwithstanding the smoke and gases were converted into flame, it was found that the production of steam was diminished from 25 to 30 per cent., and only when there was sufficiently ample boiler power to allow of heavier firing, and burning from 25 to 30 per cent. more coal, could the previous supply of steam be obtained. The most extensive experience, and the most exact experiments, alike concur in establishing the accuracy of these figures.

The analysis we have made of the varying conditions of the furnace at different periods of the coaling interval, and of the sequence of chemical changes of which these varying conditions are productive, not only enables us to explain how, and why, this great diminution in the generation of steam occurs, but places us on a vantage ground of knowledge from which the necessity of such a result is foreseen. So dark, however, has been the pall of ignorance that has rested on the subject, in such mystery have the chemical operations of our furnaces been shrouded, that for half a century each year has seen the advent of some new scheme, identical with its predecessors in the folly of allowing a constant supply of air to enter the furnace above the fuel, but vainly pretending to elude the evil consequences inseparable from such a practice, by trivial alterations in non-essential details. Strange to say, the persistence of these evil results, after the *shape* of the orifices for the admission of air had been changed from round to square, and from square to oblong; the *material* from firebrick to cast-iron, and from cast-iron to wrought; the *position* from the door to the bridge, and from the bridge to the flues; instead of opening the eyes of the experimenters to the common ground of failure inherent in all their attempts, caused them to adopt as an indisputable maxim the dogma "that smoke can only be burnt at the cost of fuel," a doctrine most correctly describing the result of the faulty expedients they resorted to for obtaining this object, but widely the reverse of truth when enunciated as a general law.

When a continuous stream of air is allowed to pass into the furnace above the fuel, about six times the required quantity of air enters and mingles with the products of combustion, and the great resulting waste of fuel, amounting to from 25 to 30 per cent., will be seen to be a necessary consequence, by all who have followed the exposition I have given of the great reduction in temperature inseparably attendant upon the entrance of a large surplus body of air into the furnace.

The fact is, the policy of admitting air above the fire, is governed by the very simple law that no more should be admitted than is required to furnish the quota of oxygen necessary for the perfect oxydation of the gases rising from the fuel at the moment. The quantity required is greatest after coaling, gradually diminishes in amount throughout the space of about five or six minutes, and then ceases altogether, the increasing draft in the stack having become sufficient to supply through the grate bars the diminished and diminishing wants of the fuel.

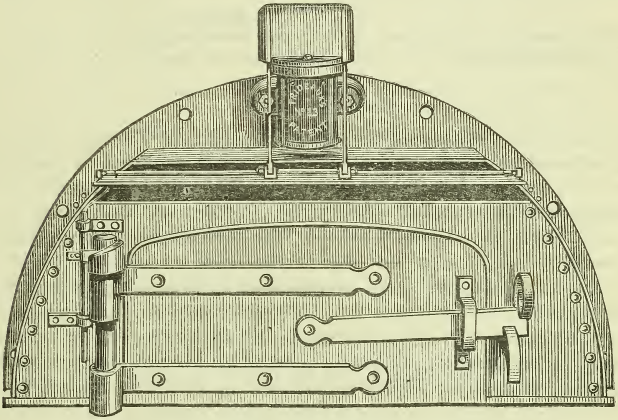
To secure the entrance of the required amount of air and no more, to ensure that this supply shall vary in quantity *pari passu* with the wants of the fuel, that is to say be greatest after coaling, gradually diminish in amount throughout a space of about five or six minutes, and then cease altogether, it is indispensable that the regulation of the feed of air be placed under the control of automatic mechanism, which not only far surpasses in regularity as to time, and equability as to motion, the limits attainable by the utmost watchfulness of man, but is free from the liability to the omissions from negligence, inseparable from human superintendence, especially where, as in the present instance, that superintendence would be of an exceptionally monotonous and wearisome character, and carried on in an atmosphere most oppressive and exhausting.

The front of every furnace should be supplied with air passages of an area equal to the admission of the largest required amount of air, and opening into the furnace by small perforations or grating for finely dividing and heating the air, but communicating exteriorly with one common mouth fitted with a valve closing automatically in any desired period of time. This valve is to be thrown wide open upon closing the door after coaling, when it immediately begins to close gradually, supplying the furnace with the great desideratum, a gradually diminishing feed of air throughout the five or six minutes' interval for which it is adjusted.

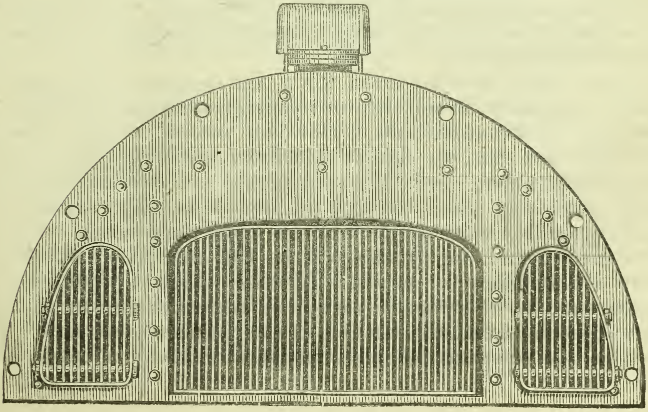
To illustrate my views on the subject in a practical form, I have placed before you on the table an apparatus which I consider fulfils the required conditions. Without admitting any superfluous air it converts into flame the carburetted hydrogen rapidly evolved after coaling (and wasted under the present unintelligent system of furnace management, apparently as a matter of course). The economy resulting is from 8 to 10 per cent. with best Welsh, and from 16 to 24 per cent. with bituminous coal, and since the apparatus presents no objectionable feature to counterbalance these advantages, but on the contrary increases the steam supply, diminishes the temperature of the stoke-hole, prevents smoke, and increases the durability of the sails, I venture to predict that, when the incredulity of ignorance as to possible saving of fuel, which now flourishes, becomes replaced by an intelligent insight into furnace operations, its use will become universal, and it will be regarded as being as indispensable an adjunct to the furnace, as the governor now is to the engine.

Prideaux's Fuel Economiser, or Automatic Apparatus for Regulating the Air-Supply of Furnaces.

Front View.



Back View, opening on interior of Furnace.



DIFFERENT SYSTEMS OF FURNACE MANAGEMENT COMPARED.

Systems.	Results.	Coal burnt.	
		Bituminous.	Welsh.
Old, and still prevailing. No air admitted above fire.	SMOKE. Hot furnace door.	100	90
Annually tried under a new alias for fifty years past, but always abandoned. Constant admission of air above fire.	NO SMOKE. Diminished steam supply.	130	110
Plan of the future. Air admitted and cut off by Automatic Air Regulator.	NO SMOKE. Increased steam supply. Cold furnace door.	80	80

To discard the use of self-acting mechanism for closing the apertures for the admission of air, and elect to effect this object by hand in preference, is a step as retrograde as going back in the construction of the steam-engine to the era of Humphrey Potter, and stationing a boy to open and shut the valve between the cylinder and the condenser. Adequately to appreciate the obtuseness and stolidity involved in the adoption of this oft-tried and abandoned system of shutting by hand, when self-acting mechanism invented specially for the purpose is in existence, so perfect in its action as to leave nothing to be desired, we have only to consider that, even supposing a man were detailed for the purpose, whose sole duty would be to stand with a watch in his hand to shut off the air supply at the right moment, twice the proper quantity of air would enter the furnace; whilst how hopeless of attainment is even an approximation to such a result, except in an experiment, all having any practical knowledge of stokers, stoking, and stoke-holes, can decide for themselves.

I will now draw your attention for a few moments to a subject by no means inoperative in relation to consumption of fuel, I allude to the temperature of the stoke-hole. However perfect we may make our furnace arrangements, we cannot withdraw ourselves from a certain amount of dependence upon the intelligence and attentiveness of our firemen. And very sure I am that the less exhausting we render their occupation, and the more comfortable we make the place in which they perform their duties, the greater will be the amount of attention the furnaces will be likely to receive. Indeed, I think it would be to be regretted were it otherwise, so very little regard, according to my experience, does the humanitarian side of the question command. There cannot be two opinions but that far greater strain is made on the physical energies of a fireman by working in a temperature of 120° than would be occasioned by performing the same duties in an atmosphere of 100°. In fact, the depression of the vital powers that ensues in tropical climates, where the heat of the stoke-hole often mounts up to 135°, is a fertile source of disease, and loss of life. Now experience authorises my saying that there is hardly a ship in Her Majesty's Navy in which the temperature of the stoke-hole might not easily be reduced from 20° to 30°.

The same apparatus which regulates the air-feed forms a most efficient agent for preventing the radiation of heat into the stoke-hole, from the fire door and front of the furnace, never becoming so hot but that you can place the back of your hand against it. As to the other great source of heat, the smoke-box doors, they should be fitted with what I have designated "non-conducting shields." These are made of tin, are light, easily applied, and productive of no inconvenience of any kind, and, at the same time, are so effective in resisting the passage of heat, that, in conjunction with the air-feeding apparatus, they cause the stoke-hole to be on the average at least 24° cooler.

As an advocate of the comfort of the fireman, I am glad to be able to adduce in support of my own opinion that of Staff Commander Balliston, of the "Elfin," who, in his official report, says, "I cannot "speak too highly of the smoke-box doors supplied for trial. They "are simple, and easily applied to all steam vessels, neither do I consider them the least in the way, as they are fastened on to the present doors, and can be taken down or put up at pleasure.

"I consider their merits are even better than the enclosed report of "the temperatures taken with the doors on now, and the corresponding account of the temperature taken last year when they were not "supplied. My reason for saying so is, that, from the confined space "of the stoke-hole, the thermometer is obliged to be placed in a corner "out of the way of the stokers, where the heat must necessarily accumulate. The patent doors are so cool that you may place your hand "upon them without feeling the least warmth; the same may also be "said of the front of the patent fire-door.

"The thermometer, when placed on the patent smoke-door, showed "92°; and when the door was taken down, and it was hung on the "flue-door, it immediately went up to 116°, thereby showing a difference in the temperature of 24°, and that in a place where the stokers "have to work."

My attention was first called to the great heat firemen are often subjected to in stoke-holes in the following manner:—My first experiment was made by permission of the Admiralty, at my own expense, in Portsmouth Dockyard. A thermometer with its bulb in contact with the face of my fire-door never marked more than 64°, whilst the adjoining door of the same marine boiler was sometimes red with heat. The contrast seemed to strike the Naval Officers who witnessed it as something marvellous. The first lieutenant of a steamer just returned from the West Indies observed to me, "Mr. Prideaux, your apparatus "will lead to a considerable saving of fuel. I don't mean by producing "more perfect combustion, which it *may* or may *not* do, for I have not

" tried it; but it will save fuel by enabling the men to tend the fires " with more comfort. My experience is, that a high temperature in " the furnace-room always tells its tale in the consumption of fuel; for " whatever people may think, careful stoking does not take place in an " atmosphere of 140°, and it is not in human nature that it should."

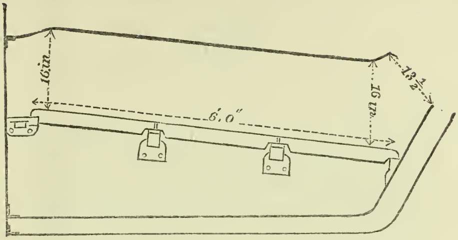
He also informed me that when commanding the "Bull Dog" in the Channel the summer before, he had had several instances of stokers fainting, and being obliged to be hoisted up on deck by tackle, to be revived by the fresh air. The thermometer in the stoke-hole indicated 140°, and the firemen could not handle their implements without binding cloths round the handles. It seemed to me monstrous that men should be tortured in this way if it could be prevented, and so I devised these non-conducting shields; and it should not be overlooked that, in addition to keeping down the heat of the stoke-hole, they prevent a waste of draft power. I determined from the first never to make an article of profit of them, and I have always offered to supply owners of steam vessels with them at cost price.

In treating of so important a question as the economic production of steam power within limits so inadequate to do justice to so extensive a subject, that some departments must necessarily be left comparatively in shadow, I have felt I should best consult your wishes to acquire, and mine to impart, useful information, by endeavouring to emphasize those points at present least understood and most neglected. In endeavouring to fulfil this intention, I find I have already occupied so much of your time on the right management of the furnace, that it will be impossible for me to advert in more than general terms to the structural details of the boiler and the engine. It must suffice to say, that in the past, attention has in the former, been directed too exclusively to the amount of grate, bar, and heating surface, to the comparative neglect of securing the due circulation of the water, and an adequate amount of what I have designated *flame space*, that is, a sufficient distance between the end of the bars, and the beginning of the tubes, to admit of the completion of the formation of flame before the products of combustion enter the latter.

If you take a piece of wire gauze, and insert it across the middle of the flame from a gas burner, or candle, you will find that the portion of the flame above the gauze becomes immediately extinguished. We have flame *below* the gauze but smoke *above*. The inflammable mixture of air and gas, which would otherwise form the upper portion of the flame, is cooled down by contact with the wire net work below the point of ignition. What the wire gauze does in the experiment with the flame of a gaslight, viz., prevent combustion by cooling the mixture of air and gas below the point of ignition, the surface of the boiler tubes (kept comparatively cool by contact with water) effect with the gases rising from the furnace, and hence waste of fuel takes place as a matter of necessity, where the distance from the end of the furnace bars to the beginning of the tubes, is not sufficient to admit of the completion of the development of the flame; the gases which otherwise would have formed flame, passing off as smoke, or being deposited as soot.

Fig. 1.

Scale $\frac{1}{3}''$ to foot.



A few days ago, sorting over some papers, I came on a tracing (Fig. 1) endorsed "order declined," which forcibly illustrates how little the necessity for a flame-space has been understood up to a comparatively recent period. It was sent to me by a firm on the Thames as a guide for making a set of my furnace doors for a steamer in process of building. I wrote back suggesting that 6 inches should be taken off the bars, and 6 inches added to the flue, and the crown of the furnace raised at the back, and stated that, notwithstanding the tubes would be shortened 6 inches, I would guarantee the furnace should make more steam, and burn a very much smaller quantity of coal. I was told in reply that they had been obliged to make the most of the limited space at their disposal, and requested to proceed with making the doors. This, however, I declined to do, assigning as a reason that the proportions of the boiler were so radically bad, that nothing but disappointment and discredit to all concerned could attend on its construction as designed.

Now in this case the prevalent faults in boiler construction are carried to such an extreme of badness that I doubt if any of you ever saw such a boiler at work, for it would fail so utterly in generating steam that I imagine, after a short trial, it would be thrown aside as worthless. You will observe there is absolutely no provision for a flame-space, and, as a necessary consequence, the heated gas coming at once in contact with the cold tubes, is cooled down below the point of ignition, and instead of forming flame to raise steam, produces soot to coat the tubes. The prevention of smoke in such a furnace is a physical impossibility and the waste of fuel enormous.

Fig. 2.

Fig. 2 is a sketch of the furnaces of H.M.S. "Princess Royal." This is a great advance upon the preceding, for this is a workable furnace. Nevertheless the prevalent faults above alluded to, are only diminished, not removed. The bars are too long, and the flame-space much too short and narrow, to obtain the best results even with Welsh coal, whilst were bituminous coal used, smoke, with its attendant great waste of fuel, would ensue, especially when steaming at full speed. Since a boiler with a flame-space of sufficient dimensions to allow of the inflammation of all the gas from bituminous coal, is perfectly well adapted to burn

Welsh coal, I think it is obvious that all the boilers for the Navy should be so constructed. In this case, even when supplied with all bituminous coal, which must occasionally happen in time of war, smoke could always be prevented. I hardly know a subject on which so great and wide-spread a misapprehension exists, as that entertained with regard to furnaces making smoke. If the flame-space of a furnace be not sufficiently roomy to admit of the full development of the flame, the prevention of smoke is a physical impossibility, but if the flame-space be sufficient, nothing can be easier. A few holes in the door or bridge, or the furnace-door left ajar, are sufficient to prevent smoke. But such, or any mode of preventing smoke by the admission of a continuous supply of air above the fire, necessitates 30 per cent. more coal being burnt to obtain the same supply of steam. This it is which has imparted to the nuisance its vitality, and not the existence of any difficulty in the attainment of the object itself.

Fig. 2.

1″ to foot.

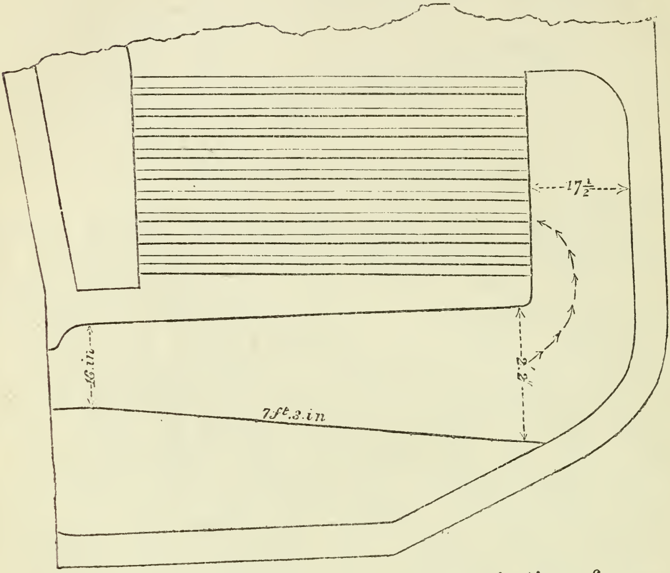
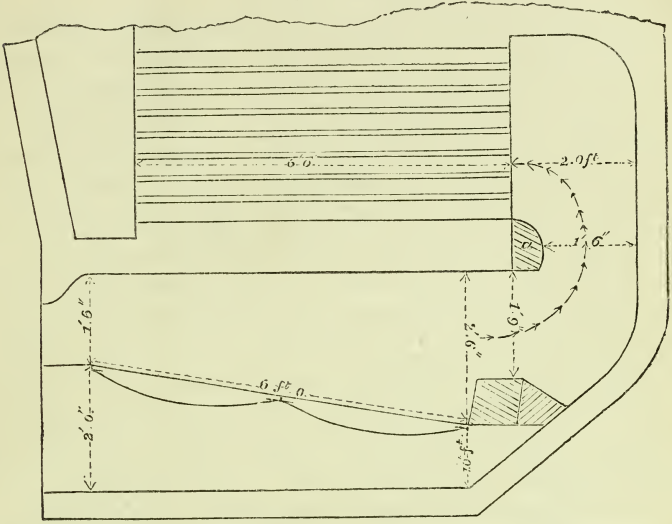


Fig. 3.

Fig. 3 embodies my views of what the proportions of the existing type of a naval boiler should be. You will observe it affords ample space for the full development of the flame of the most bituminous coal before the products of combustion reach the tubes, and it might be fed entirely with bituminous coal without an atom of smoke being visible, whilst it would give better results in regard to economy than any naval boiler of the kind it has been my lot to meet with. It possesses a novelty in a bridge (*a*) of firebrick which spans the flue, with its under side level with the crown of the furnace. By preventing the current of heated gases taking so short a curve as would otherwise be the case, it materially contributes to their more equable diffusion through the tubes, remedying the fault at present complained of, that the major portion passes through the lower tubes, leaving but little to find its way through the higher, which is in reality tantamount to a diminution of the heating surface.*

Fig. 3.

⅓″ to foot.



Before quitting the first branch of our enquiry, viz., "How to evaporate the greatest weight of water with a given weight of fuel hinging on the structural arrangements and management of the furnace and boiler," I am desirous of bringing prominently under your notice the fact, that since the office of the boiler (including the furnace) begins and ends with the evaporation of water, the proper way to test the work it performs, is *to measure the quantity of water it evaporates*, by fitting every boiler with a water meter, instead of estimating its duty in the very vague and unsatisfactory mode in use at present, viz., by the performance of the ship it serves to propel, thus subjecting the results to all the uncertainty inseparable from a variety of contingences such as defects in packing of pistons, in valves, in bearings, in condenser, or other portions of the engine, and the vicissitudes of winds, tides, currents, and sea, and the state of the ship's bottom, propeller, &c., &c., the effects being to import such an amount of uncertainty into the results, that the formation of positive conclusions and comparisons is rendered impossible.

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* In 1857 I made an offer to the Admiralty to improve the furnaces of H.M.S. "Impérieuse," saying I could do so very inexpensively, whilst they could be restored to their previous form if thought desirable; that this would not likely be the case, as the alterations I should make would not be *experiments*, but founded on a knowledge of the subject, acquired by having for seven years past made the specialities of furnaces almost exclusively the object of my study, in addition to which, during the last two years I had had the experience of adopting my automatic furnace-door to 600 furnaces of the most varied character, adding, "whenever an opportunity is afforded me, I shall be happy to give the country the benefit of my long study and experience on this subject; and I unhesitatingly affirm, that boilers may be constructed greatly in advance of these at present used in the Navy."—T. S. P.

In carrying out scientific experiments, the first thing considered is, how best to eliminate sources of error by securing as far as possible the existence of similar conditions during each experiment of a series, for thus only can reliable results be obtained. In their experiments on "Baxter's mixture," the Admiralty had put to sea in search of variable conditions, and after being at work in the "Lucifer" and "Urgent" for three years, had apparently failed to arrive at any useful or decisive conclusion. In fact, I do not suppose they have added one grain of positive knowledge to our previous stock. Now had they put to me in a definite form the question they wanted solved, I would have undertaken to have given them an answer in three weeks instead of three years, and one which no subsequent amount of experimenting would ever have invalidated. The probability, however, is, that I could have given them an answer without experimenting at all. As Naval Officers, what would you think of sending a gun to sea to test the accuracy of a new mode of rifling, and determine the target figure? Now to a chemist, testing the value of a fuel by the locomotive performance of a ship, which means measuring the results at the tail-end of a set of variable conditions, was equally absurd. It was lamentable to see such a want of intelligence exhibited in the conduct of public affairs, for it not only caused a great waste of money, but discredited the nation in the eyes of foreign states.

The first step to progress, or rather an indispensable preliminary to taking the first step, is an accurate knowledge of our existing position, and it always has been my opinion that what I cannot but regard as the present highly unsatisfactory amount of coal burnt, to power obtained, is greatly to be attributed to our habitually neglecting to determine by exact measurement, the actual work performed by the fuel in water evaporated. Many years ago I took considerable trouble to induce the Admiralty to fit the boilers of all Her Majesty's ships with "water-meters," and keep a record of the duty performed in weight of water evaporated, for coal expended, believing the adoption of such a system could not fail to be ultimately productive of a greatly increased economy of fuel, but my efforts were not successful.

In reviewing the present state of the question of economy of fuel as a whole, I confess the point which presents itself most forcibly to my mind, both from the waste it entails, and the degree in which its existence is overlooked, is the circumstance that in the management of our furnaces we make no provision for the widely different conditions as to air supply, which ought to prevail, as more or less time has elapsed after coaling, involving the more or less rapid evolution of gas, or coke alone remaining to undergo combustion.

The SECOND BRANCH of our subject, "How to obtain the maximum mechanical effect from a given quantity of steam," dependent upon the construction and management of the engine, is, no doubt, a far more attractive subject for enquiry than furnace-management, and one which commands a far greater amount of attention, and on some future occasion I may perhaps have the pleasure of presenting you with some analysis of its details. For the present I must content myself with saying in general terms that a very general agreement now exists as to the channel through which increased economy is to be sought, viz., by increasing the extent to which the steam is used expansively, through employing steam of higher pressure, and applying heat to the surface of the cylinder. A great increase in economy has been effected by travelling on this road, and I cannot doubt but that it may be pursued still further with advantage. In my treatise on "Economy of Fuel," published in February, 1853, I gave an estimate of the theoretic capabilities of a steam-engine working at 90 lbs. pressure, and cutting off at one-sixth, with the exterior of the cylinder preserved at the same temperature as the boiler, observing "the time will come when it will be quite an exceptional case for an engine to be worked at a lower pressure, or at a lower grade of expansion than this, for the simple reason that there is nothing to prevent this degree being generally used, and, therefore, to employ less will be considered as sacrificing economy without an object." At this period the general pressure employed in the Navy was 10 lbs., whilst there was not a single steamer afloat provided with any appliance for applying heat to the cylinder.

Shortly after a consultation was held by desire of the Admiralty, at which it was decided that a considerable increase, I think to 26 lbs., should take place, and I was informed by a gentleman present that my book, which had then just appeared, was quoted in support of the opinion that a much higher pressure might be adopted with perfect safety and great advantage.

From that period to this the pressure has gradually crept up till from 45 to 50, and even 60 lbs. pressure is now not unfrequently used in marine boilers, and I am quite satisfied this progressive advance will continue till the pressure of 90 lbs. is reached, for the simple reason as I then stated, "that there is nothing to prevent this pressure being generally used, and, therefore, to employ less will be looked upon as sacrificing economy without an object."

I do not believe, however, that we shall rest at 90 lbs. Other conditions being equal, the higher the pressure the greater the economy, but as we mount upwards in pressure, certain impediments, certain drawbacks present themselves. Now locomotive engineers being shut out from the advantages of condensation, have had every inducement to increase their pressure till some barrier was encountered which rendered further advance no longer advantageous, and I find they have settled down to working with from 120 lbs. to 140 lbs. on the guage, or, in other words, using steam of from 9 to $10\frac{1}{3}$ atmospheres, and I have no doubt but that in marine engines we shall ultimately come to much the same practice. Could I afford the luxury of a steam yacht, I should certainly arrange to work with steam of 9 atmospheres, and cut off at $\frac{1}{10}$, and by combining with this degree of pressure and expansion increased economy of fuel by the use of my automatic apparatus for regulating the air supply, I should expect to attain an economy of about 1 lb. of coal per indicated horse-power per hour. If I live a few years longer, I believe I shall see this degree of economy realised, and I do not hesitate to give the opinion that when we have arrived at this point, we shall have nearly reached the utmost limits which the nature of the subject renders practically attainable.

Lightness and simplicity of working parts powerfully contribute to economy of fuel, and I think we are justified in expecting to see great advances made in the future in these directions.

Here is a small model of an engine of novel construction which I have recently met with, which appears to me to offer peculiar advantages in many points for marine use, and which, if I am not greatly mistaken, has a future before it. Half the cases of steam ships breaking down arise from either the crank or the connecting-rod breaking. This engine dispenses with both. The speciality which first attracted my attention as marking it as peculiarly adapted for marine use, is its economy of space. It requires only five-eighths the space of the shortest connecting-rod engine, whilst in regard to friction I think it will compare advantageously with the trunk engine.

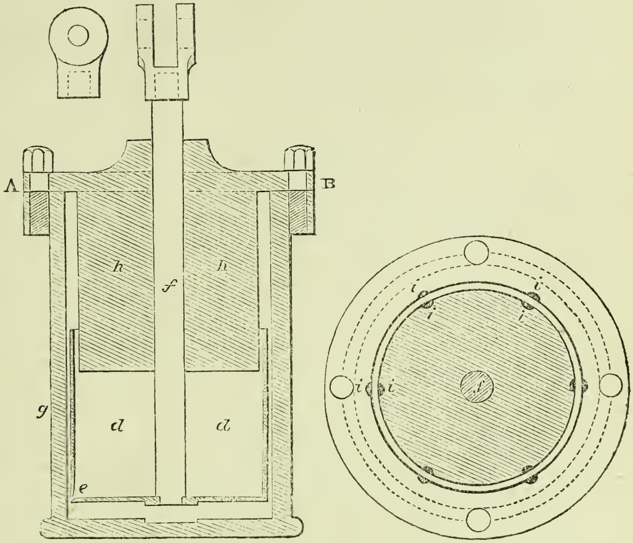
I am also assured, on testimony on which I can rely, that its average weight and average cost will not exceed five-eighths of that of marine engines of the ordinary form. An engine of the kind, of 20 horse-power, has now been in constant work night and day for two years pumping the water for a paper mill in the vicinity of London without once requiring repair.

Besides lending the model for exhibition this evening, the proprietor has kindly given me permission to invite any gentleman interested in the subject to see the pumping engine at work.

There is one phase of the question of economy of fuel on which I have not touched, viz., that concerned with husbanding the resources of the steam-power at command; on what occasions slow speed should be used, and on what the use of steam-power dispensed with altogether. But these are questions of seamanship on which it would be presumptous in me to offer you advice, and if not presumptous, superfluous, since the subject has been most ably handled by a gallant Officer whom I have the pleasure of seeing here to-night, Admiral Ryder, in a book well deserving of being more widely known.

The Chairman: Is yours a self-acting apparatus to admit the air?

Mr. Prideaux: I daresay the Members of this Institution are aware that I have been at work at this subject for a very long period. This drawing represents the first apparatus that I had for self-closing. This is a water cylinder which is fitted with a vulcanised cap of india-rubber. This piston is the same kind of piston as is used in the hydraulic press. You may move it up rapidly, because the india-rubber side collapses and allows the water to pass. When it is up, the india-rubber expands by the pressure, and it can only pass down as the water below travels through this small aperture (the size of which is regulated by a screw), and comes over the top. The only defect in this apparatus was, that it wanted to be filled with water every day. When it was filled every day the india-rubber piston lasted, on an average, nine months. In fact, it just amounted to this, that when the engineer took an interest in the thing, it was easily kept in working order. In the "Argus," under Captain Grandy, it worked exceedingly well. Sulphur is used in the preparation of vulcanised india-rubber, and I had a few cases where some peculiarity in the water induced chemical action, and crystals of sulphate of copper were deposited; but the occurrence was rare. There is no doubt that this new apparatus is a considerable improvement upon the water cylinder. It entirely dispenses with any superintendence; it does not require any filling up.



The cistern, *d*, being filled with mercury and placed at the bottom of the cylinder, *g*, upon raising the cistern, the cylindrical plunger, *h*, enters the cistern, causing the mercury to flow over its sides and pass through the grooves, *i*, to the bottom of the cylinder. The raising of the cylinder rod lifts and opens the air-valve, when the weight of the flap, slightly depressing the cistern, causes the mercury to rise in the grooves and round the sides of the cylinder considerably above the level of the bottom of the cistern, and, as a consequence, to flow into the cistern through the small orifice, *e*, causing it gradually to descend and the air-valve to close in a time proportioned to the size of the orifice and the area of the cistern. This apparatus will work from an hour to a minute. That is set for six minutes, which is about the average time for a marine furnace. I have had this apparatus working six months in a stokehole, without any cap over it. You observe it is capped like the works of a watch, so as to prevent any dust getting into it. I feel very confident it would work throughout the three years of a ship's commission without once requiring adjustment. In fact, I see no reason why it should not work for twenty years.

The Chairman: When you open the furnace-door, it opens the valve-box, and after you shut the door, the apparatus gradually shuts itself, and cuts off the supply of air.

Mr. Prideaux: Shuts itself in any time that it may be regulated for. Marine furnaces would be from five to six minutes. The cistern contains 5 lbs. of quicksilver.

Captain Burgess: What is the cost of that apparatus, including the fitting of it?

Mr. Prideaux: A single one is about £20; if there are several of one size they come to less.

Captain Hoseason: What is the royalty to an engineer?

Mr. Prideaux: That includes royalty and everything,—the entire cost.*

The Chairman: I think you will all agree with me that this is a most important subject that Mr. Prideaux has lectured upon. I think no engineer or naval man can differ as to the great importance of some apparatus for consuming smoke. The only question, it appears to me, is what is the best plan for accomplishing the object. Mr. Prideaux has explained very clearly, both in his lecture and by his diagrams, that there would be a very great saving in the consumption of fuel according to his plan; and I have not the slightest doubt about it, as long as this apparatus works properly, and the door is kept clear of dust and dirt. The only thing that puzzles me is, that the plan has been before the Admiralty so very long, and they have not adopted it. But that does not at all imply that it is not the right plan. We all know that the Admiralty very often take up plans which, in my opinion, they ought not to take up, and cast aside plans which they ought to take up. According to what I understand, the plan for consuming smoke that they have adopted is the plan of Mr. Murdoch, a naval engineer. It acts upon a different principle from that of Mr. Prideaux; instead of a current of air over the top of the fire, it admits the current of air at the back of the bridge; and it equally consumes the smoke. But this (Mr. Prideaux's) apparatus does not interfere with the size or proportions of the furnace at all. I suppose every engineer when he makes his engine calculates the size of his fireplace, and that everything is most correctly proportioned. If you take his (Mr. Murdoch's) furnace, and cut off one-fifth from the end of it, supposing it is calculated to burn a certain quantity of coal, you diminish his power of producing steam. Therefore, if all the fireplaces in the Navy are to be altered on Mr. Murdoch's plan, and this plan of Mr. Prideaux's would answer equally well, without the necessity of making any alteration in the furnaces, I think it would be preferable to adopt it. I hope some gentleman will give us his opinion on the subject.

Admiral Wellesley, C.B.: If I am not trespassing too soon, there is one point with regard to this subject which Mr. Prideaux might explain. It is with reference to these self-acting doors. If I understand rightly, when that door is open the quicksilver is pumped up, or whatever the process may be, and as long as the door is open, nothing takes place. But the moment the door is shut, the valve begins to act, and then five minutes must elapse before it has gone down again. Supposing the engineer to walk along his stokehole, and that he wants to have a look at his fires as he goes along, in order to see that his people are doing their work properly, he throws all his doors open each time, and consequently the moment he opens the fire door the quicksilver is pumped up again, the valve is raised, and the process is all gone through again needlessly. Then, again, it is no novelty admitting the air over the top of the fire-place. It has been done by our engineers for themselves; they have been in the habit of perforating the front door; but the difficulty they had was that the holes were always there. As I understand it, the merit of this plan is that it is a self-acting apparatus. It would be so if you were always to fill your furnace by means of it, and let the fire remain thirteen or fourteen minutes. But that will not do for a naval engineer, who wants to be going along, constantly, looking at his fires and having his doors open. As I understand, every time that door is open, the valve is raised again, and it requires five or six minutes to close the valve. I only want to know whether the engineer can disconnect it in any way.

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* With regard to the question of price, I am desirous of observing—

1st. That the dimensions of the air-passages in each furnace-door and front are a matter of calculation, each having to be constructed with reference to the furnace for which the door and front is designed.

2nd. That the workmanship requires to be of the best character, and great solidity, to maintain the apparatus in working order, amidst the dirt and heat of the stokehole from one year's end to another, without requiring even cleaning, a desideratum attained for the first time, in the present apparatus.

3rd. That, on an average, the price charged, is repayed by the saving of fuel in three months.

4th. That I have always offered to accept six months' saving of fuel, as payment for the apparatus.

Mr. PRIDEAUX: You need not make the air valve self-opening. It is perfectly easy to make it the duty of the fireman to open the valve after coaling. Then of course it would not open of itself with the opening of the door. But if the engineer opens the door to look at the fire, when he shuts the door he has only got to close the valve down at once. You cannot have it both ways. Holes that are always open admit about six times as large an air supply as this apparatus.

Admiral WELLESLEY: Supposing the engineer should wish to look at his fires before it is time to coal, then by opening the door he opens the air-feed.

Mr. PRIDEAUX: At first I did not make it self-opening, but only self-closing, maintaining that you ought to have firemen sufficiently intelligent to understand and remember that when they shut the door after coaling they had to lift this air valve up, and then it would shut itself. But we find that our customers generally prefer to have them self-opening as well as self-closing; but you can shut the air valve down close at any moment if desired.*

Admiral WELLESLEY: Exactly; that meets my question.

Admiral RYDER: You spoke of the tin shields.

Mr. PRIDEAUX: What I call a non-conducting shield. They are closed air chambers of tin. Air is an exceedingly bad conductor of heat. These shields are screwed on to the flue doors. They are very slight and easily taken off.

Rear-Admiral RYDER: Mr. Prideaux has kindly alluded to a work of mine on "Economy of Fuel," long out of print, published some twenty years ago, which touched upon various parts of this subject that he has not alluded to. The subject is a very wide one. I am sure it could not be discussed properly to-night; I doubt if it could be discussed in less than two or three nights. "Economy of fuel" includes many branches; I will run over a few of them, very shortly, to show what a large subject it is, and what a great deal there is in it. The particular branch of the subject dwelt upon by the Lecturer, viz., the introduction of air into the furnace, is very important, and his doors appear to meet the difficulty. After considering the title of the paper in all its width, one may fairly say that the question each naval Officer would naturally have asked himself before coming here to-night was, what part of this very large subject, "How can the economy of coal be best promoted in "the Navy," is to be considered by Mr. Prideaux to-night. We now know, thanks to the most interesting and instructive paper read by Mr. Prideaux. Well, but let us take the broadest part of this very wide subject first, viz., the question as it must be considered at head quarters. At once we find ourselves face to face with that moot question, What is the most *suitable* and most *economical* kind of fuel to be supplied to ships of war, and are the terms convertible? This is a very large subject with which naval Officers in command of ships have practically nothing to do, for we must take what coal is given to us, and make the best we can of it. Another very important question relates to depôts of coal abroad. This bears also, like the preceding, upon economy in the *gross* sum expended upon coal yearly. The necessity of our having numerous fortified depôts for coal, the coal being covered and not kept too long, was touched upon in a very interesting paper read last year by Captain Hoseason, R.N. This, again, is a very large subject, and a most important one, which would take a long time to discuss. We have all heard a great deal lately of the question of the "mixed coal" which is now supplied to the Navy. I hope we shall soon have some some facts from the Admiralty detailing the experiments which have been tried across the Mediterranean, and comparing the economical merits of Welsh coal with those of the Admiralty mixture, and of north country coal by itself. I believe, from what I have heard, it will be shown that Welsh coal is very much more economical in all respects, even to the extent of 20 per cent., than the "mixture." At the same time there is this to be said on the other side, and it must not be forgotten, viz., that the Welsh coal, if stowed in the tropics, is said to deteriorate sooner, owing to its friability (not to any chemical change) than all other kinds of coal. It is well, therefore, that our furnaces should be fitted, if possible, so as to burn Welsh coal well and economically, and also to burn well and economically other kinds of coal, if, indeed, we can have furnaces so fitted. If we cannot, then I agree with Lord Lauderdale we had better have our furnaces fitted to burn, at all events, well and economically the Welsh coal that we shall endeavour to supply our ships with in war. Experiments on the relative merits of different descriptions of coal under all circumstances should be commenced at once.

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* In point of fact, however, opening the door a little to look at the fire hardly opens the valve at all; only when the door is thrown wide open, as for firing, is the valve widely opened.

The CHAIRMAN: We must first be satisfied that the north country coal does keep better in a hot climate than the Welsh. I entirely dispute that.

Admiral RYDER: Perhaps you may be right, but I only say it has been stated so. The person who gave me the information was Rear-Admiral Sir William Mends, who has had a great deal to do with coal depôts for troop-ships. The information he gave me was in print, and professed to be a report on the deterioration of coal *abroad*. These are two of the points which occur to me as forming the broadest part of the subject.

When we are treating of the economy of fuel in the Navy, we at once see the importance of our having the most economical engines and boilers in the ships, economical as regards the consumption of fuel, as well as of wear and tear. The Committee of Designs, of which I was a member, received much evidence on this point a few months since, and satisfied themselves that the compound engine is by far the most economical engine that we can have, and that the pressure on the boiler is being increased year by year. The compound engine will burn a less quantity of coal per indicated horse-power than any other, approaching to 1 lb. per indicated horse-power per hour. The expansion gear should cut off as early as one-twentieth of the stroke, and the ports should be much increased in size. Having got our engine and boiler on board, and the ship in our hands, the question, of course, presents itself, what is the most economical way of managing the fuel when you have got it on board? There is no doubt about it that the more you can use sail, and the less you rely upon coal, simply *quâ* economy, the better. It is then a very important question to what extent should our ships be masted, and to what extent should they have engines? This is a large question, indeed, and it would take a very long time to discuss. I am of opinion that no ship-of-war, except vessels for *harbour* defence only, should be without a sail equipment sufficient at least to make them manageable in a gale of wind, and aid them in making passages, and that the majority of our men-of-war should be fully rigged, and so constructed that they should be able to beat to windward under all plain sail in smooth water more than one mile an hour.

In the next place there is the most important question of working steam *expansively*, which I am sure Captain Hoseason will allude to presently, as he can speak on it with more weight than I can. It is a question which ought to interest all naval Officers, and which I am afraid is often overlooked by those of them before whom it has not been properly brought. I have, when taking passages in ships-of-war, been startled to see how little the expansion valves of the engines were considered or used with judgment, and how often ships were burning a great deal more coal than they ought, simply because the steam was not used as expansively as it ought to be. This, also, is a very large question which would take a long time to discuss. There is another matter germane to it which has often occurred to me, and especially when I was last afloat. I communicated with the Admiralty upon the subject, and they desired me to draw up a draft circular on Economy of Fuel. A part of this circular was adopted.* The point I raised was this:—I think it will be admitted by everybody, when they consider the subject, that always in ships without masts, and frequently in masted ships, with foul wind or calms, steam must be used, but that if there is no particular object in reaching your port on a particular day, the most economical speed for the *voyage* will be, *cæteris paribus*, that which will cause the least consumption of fuel "per mile" (you must always carefully distinguish between "per mile" and "per hour"), and which will be either under sail alone, *if* there is no urgency whatever in the orders, or else some definite speed to be ascertained by experiment. Now the most economical speed under steam "per voyage" and per mile, is probably to go as *slowly* as possible. Of course it is, I hear some one say. But though everybody says "of course it is," they don't practice it. You will rarely find when you are cruizing that the vessel is going *as slow as possible*, and if you suggest that she should only go three and a-half or four knots, you would probably not be believed, and it would often be considered an absurdity by the Captain that he should be expected to reduce speed to three and a-half knots in a ship that can go fifteen. I do not say this is the universal feeling, but I know there is such a feeling. Officers have thought that no one has any right to hint even at their going less than seven or eight knots under steam alone, but lately, I believe, some ironclads have reduced their speed to two and a-half knots—so I have been told, and have seen in reports. When there is no object in going any quicker, the slowest speed is, as a rule, in light winds, or calms, and smooth water, the most economical speed per mile, on account of the resistance varying as the square of the speed, or nearly so. Of course we must look at both sides of the question. There is a speed in some engines which racks the engine, and causes backlash, to which the engines must not be reduced, and which although it might be the most economical speed, might injure the engine; this you have to guard against. But Officers in command should not speculate as to what is the most economical speed per mile when the breeze has freshened, or a sea got up, they should always ascertain it. If they take a little pains they can do so, and it will vary with the conditions of sea and wind which are happening at the time. Having determined what is the most economical speed per mile, they should maintain it. Of course they can proceed more quickly at any time, if there is reason for it. This is a very important point connected with "economy of fuel." Captains should always be asking themselves day by day, and hour by hour, whether they are steaming at the most economical speed *per mile*, and if not why not? One of the questions which came on the other day before the Committee on Designs (the report is on the table of the House of Commons, and no longer confidential) was this—In our large ships we have enormous engines of 1,200 horses nominal, working up to 7,000 indicated horse-power. If, as I maintain is true, the slowest possible speed is, under ordinary circumstances, the most economical per mile, and therefore per voyage, or when cruizing, then we are led up to this consideration, viz., that we have enormous engines with great friction, requiring constant supply of lubricating material, which must, somehow or other, be always driven along, even when we only want to maintain a speed of say three or four knots. Just as if a man, when driving his one horse coal cart, insisted on fastening all his stud to it, and dragging them after it. It is evident that there will be considerable loss in driving this monster, while we only want to maintain this speed of say 3 knots, and for which 200 or 300 indicated horse-power might be sufficient. Therefore, a suggestion was made, that in designing the engines for these large ships a small portion of (probably the after part of) the engine, say one-eighth, or 150 nominal horse power, should be capable of being disconnected from the rest of the engine, and be used for all ordinary occasions, viz., when you want the ship to go as slow as possible, and, therefore, as economically as possible. The Chief Engineer of the Admiralty, Mr. Wright, admitted that this would be an economical proceeding. Economy of fuel in war time will be everything, it will tend to ensure success.

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* Since this paper was read, another Circular has been issued, dated April 26th, 1872, adopting the recommendations made by me to their Lordships three years since, viz., that the speed which was the most economical *per mile* should be ascertained at the earliest opportunity in every ship, in calm weather, should be reported to their Lordships, and be always maintained under ordinary circumstances.

The CHAIRMAN: I should say with two and a-half knots you will never get to the end of the voyage. Give us a half speed of ten knots.

Admiral RYDER: Ten knots is, I admit, a very *comfortable* speed, so is that of the express train; but it may be a ruinously extravagant speed, even in a fifteen knot steamer. Of course, if coal were not an object, it is the speed one would prefer to any slower. I have crossed the Atlantic in a steam line-of-battle-ship (the "Hero") at a speed purposely reduced throughout the voyage to from three to four knots, in light head winds and calms, when had I attempted to go faster, I should not have reached my port (Bermuda) for weeks. There is another question with regard to "economy of fuel," which came before us, very prominently, which is alluded to in the Committee's Report, and is also advanced I see in the Annual just published by the Professors and others of the School of Naval Architecture, Kensington, viz., that the "turbine" promises, when thoroughly developed, to be a very economical propeller, perhaps the most economical. It is much to be hoped that the Admiralty will now take steps to carry out most thorough experiments with regard to the turbine. This is the unanimous recommendation of the Committee on Designs, one of the few important points on which they were unanimous. There is an impression abroad that the turbine must be a less economical propeller than the screw: but the writer of the article referred to speaks of it, as at all events theoretically, the most economical of the two. Its numerous other advantages are manifest, and have often been pointed out here. I have suggested to the Admiralty that to promote "economy of fuel" at sea, when under steam, an entry should be made every day by the Captain in the log at noon, and oftener if necessary, replying to the following questions: 1. What speed are you maintaining? 2. What fuel are you spending per mile? 3. What speed would be most economical in fuel per mile at this particular time, either as estimated or ascertained, by diagram? 4. If you are not proceeding at the speed which is the most economical per mile, why not? If this were ordered to be done, and Commanding Officers had every day to make that little confession, as it were, to their Commander-in-Chief and the Admiralty, I am sure that a very remarkable reduction in the total consumption of fuel throughout the Service would take place: because when a man had to answer these questions daily, it would often puzzle him to find and to give any sufficient reason why he was not steaming as economically per mile, which is per voyage, as he might. He would thus be led gently, but by an irresistibly persuasive power, to practise the utmost economy, not a senseless economy, imperilling the ship, but a wise and judicious economy. An order to the above effect would also tell upon the senior Officers, commanding fleets and squadrons; and they would certainly adopt the plan of more fully explaining than at present to the Captain in their sailing orders, either the urgency or non-urgency of the orders, or state the day beyond which it was not desirable their voyage should be extended.

. The indicator diagram, that invaluable aid to the Captain, as well as to the engineer, tells us by the "terminal pressure" what is the relative "consumption of fuel" per "revolution," and therefore per mile, when the speeds compared are not widely different. Suppose that the speed has been maintained in a calm at the slowest speed possible, without backlash or racking, say 2·5 knots, and that that speed has been ascertained by aid of the diagram to be, in a calm and smooth water, the most economical per mile. The wind freshens to a steady breeze ahead, and the revolutions (say 20) which drove the ship 2·5 knots in the calm cease to drive her ahead more than 1 knot. The 20 revolutions must evidently be increased, but by how much? The experiment should be conducted in this way:—Increase the revolutions by say two or three at a time, using the expansion gear of course, ascertaining the speed, and taking a diagram at each increase of revolutions. Then the

$$\frac{\text{No. of revolutions} \times \text{terminal pressure in tenths of inches}}{\text{Knots of speed}}$$

will give a comparative measure of the consumption of coal per mile at each speed, and the fraction which yields the smallest quotient will have as the speed involved in it the most economical speed per mile for those circumstances of wind and sea.*

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* *Example.*—The breeze having freshened ahead, the number of revolutions (20) which had previously driven the ship 2·5 knots now only drives her 1 knot, increase the revolutions successively to say 23, 26, 29, 32, 35, and let the mean terminal pressures on both sides of the piston be 10, 11, 12, 13, 14, 15, and the speeds 1, 2, 2·8, 3·4, 3·8, 4·1, then as—

$$(1)\ \frac{20 \times 10}{1} = 200.$$

$$(2)\ \frac{23 \times 11}{2} = 126.$$

Steaming against a current, the most economical speed is approximately half as fast again as the current. If current 4 knots, speed through the water should be 6 knots, over the bottom, 2 knots. As I said at the commencement of my remarks, the title of the paper is so *wide* that I have been seduced into greater discursiveness than I intended. I wish Mr. Prideaux all success.

Captain Hoseason, R.N.: As my friend, Admiral Ryder, has alluded to me in his observations, especially as to that economy of fuel that is derived from the expansive action of steam, I hope I may be able to say a few words which will, I trust, be a course of consolation to the lecturer. He has told us how many years he has treated upon this all important subject, the economy of fuel, and for what a lengthened period he has been engaged in endeavouring to push forward his invention, and that he has encountered little more than a passive resistance at the hands of the Lords of the Admiralty. Yet we all agree that the abatement of the smoke nuisance is one of vital importance both as regards efficiency and economy in steamers. There is no want of lucidity in the lecturer, therefore if those at the fountain head do not see their way clearly, it cannot be from want of having the facts placed clearly before them.

I also have been a labourer in the same vineyard with himself. It was in the year 1842, I first brought my views of the economy of fuel to be derived from a still further development of the expansion of steam before the Admiralty, and in the year 1872 I find the subject but little understood and still less cared for.

The Lords of the Admiralty caused the following letter to be written to me, dated 19th July, 1842:—"I am commanded by my Lords Commissioners of the Admiralty "to return you their thanks for your communication on the subject of using steam "expansively, and to send you the accompanying copy of a memorandum they are "about to issue on the subject to the Commanding Officers of all Her Majesty's "steamers."

They sent me the memorandum in question without ever having consulted me as to its composition, and when I came to peruse it, I found it drawn up in such English, and so unscientific, that I felt myself in duty bound in respect for my own reputation, to fully analyse their Lordships' Circular, which will be found contained in the pamphlet I hold in my hand, and which I here present to the Institution.

The lecturer in introducing this paper has, as Admiral Ryder states, opened up a very large and important question, which is daily growing in importance, seeing that our Naval and mercantile steam fleets are now nearly entirely composed of vessels whose primary power is steam. And I have only to regret that we should be called upon to discuss off hand so large and difficult a subject, and with our time, after having the paper read, so much restricted.

The Chairman: I think you will all agree with me that we ought to thank Mr. Prideaux for the very interesting lecture he has given us. I only wish we had more time to work out the subject, and that he would expand it to greater length. There would be more questions put upon the subject, because when a subject is

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$$(3)\ \frac{26 \times 12}{2{\cdot}8} = 112.$$

$$(4)\ \frac{29 \times 13}{3{\cdot}4} = 111 \text{ (the minimum quotient).}$$

$$(5)\ \frac{32 \times 14}{3{\cdot}8} = 118.$$

$$(6)\ \frac{35 \times 15}{4{\cdot}1} = 128.$$

No. 4, viz., 29 revolutions, giving a speed of 3·4 knots, appears to be the most economical speed per mile, as 111 is the minimum quotient. This case is given merely in illustration, and does not profess to be a *bonâ fide* experiment. If time admits, the actual expenditure of fuel per mile should of course be ascertained.

brought before a meeting of this sort, and only partially discussed, very little good results. There is no doubt of the necessity for consuming smoke, but the question is whether or not the smoke can be consumed. Mr. Prideaux contends that by his plan there is a gain of fuel; many engineers contend that the smoke cannot be consumed without a loss of fuel. There is a wonderful difference between the two. It would be of great importance if the question could be worked out and discussed. Perhaps Mr. Prideaux would answer any observations that have been made.

Mr. PRIDEAUX: I think that what fell from Admiral Ryder and Captain Hoseason hardly related to the particular department of economy of fuel which I have treated on to-night. With regard to what your Lordship said, I would just observe that the distinctive difference between Mr. Murdoch's plan and this plan is, not so much the part of the furnace in which the air is admitted, though that is a considerable point. There is no doubt that it is more injurious to admit a continual supply of air above the fuel at the bridge than it is at the door. But the distinctive difference between the two plans is this, that Mr. Murdoch's, if it is to be called Mr. Murdoch's, is one of the old plans in which the shutting off is left to human agency. I maintain that that is never to be relied upon, and that it is impossible by this means to regulate the air-feed correctly, because if you had a man to stand with a watch in his hand, to shut it off at the expiration of five or six minutes, which you would never get a man to do, even then twice the right quantity of air would enter the furnace. It has been tried over and over again, and it has always been abandoned. When I heard the Admiralty were trying to burn "Baxter's mixture" on such a system, I predicted from the first that they would never accomplish it. But if they had had this automatic apparatus, they might have burned the coal very well. I have proved it in vessels that were burning all Newcastle coal. I tried it in the "Elfin." For two hours Admiral Denman and myself steamed through the fleet at Spithead at full speed. So copious was the steam supply, that we had only three fires lighted out of four, and I do not think at 100 yards' distance anybody could have told from the top of the funnel that there was a fire on board the ship. It was all Newcastle coal. On the deck of the ship, as each shovel full was thrown on, you could see a trace of dust; but the moment the door was shut, it was all clear. No alteration was made to the furnace bars; the only alteration made was the substitution of my door for the common door. It certainly proved that Newcastle coal could be burned without smoke, in the ordinary marine boiler of the "Elfin."

Admiral RYDER: Do you say that the burning on that occasion was more economical than if you had Welsh coal with your door?

Mr. PRIDEAUX: I believe Newcastle coal with this door will answer as well as Welsh coal.

Admiral RYDER: The door in use in both cases?

Mr. PRIDEAUX: I think the result is about the same. Certainly, with a mixture of half Newcastle and half Welsh, if the furnace was fitted with one of these doors, you would not see any smoke from one month's end to another, and you would have a great economy of fuel; and, certainly, an increased quantity of steam.

Evening Meeting.

Monday, February 19th, 1872.

Rear-Admiral A. P. RYDER, in the Chair.

NAMES of MEMBERS who joined the Institution between the 6th and 19th February, 1872.

LIFE.

Lyons, T. C., Col. late 87th Regt.
Baillie, Hugh S., Lieut. late R.N.
McLaughlin, Charles, Lieut., R.N.
Hewitt, Allen James, Lieut., Queen's Westr. Rifle Volrs.
Scrivener, H. B., Lieut., Queen's Westr. Rifle Volrs.

ANNUAL.

Kennett, V. H. Barrington, Lieut., Royal Elthorne Mil.
Daunt, Arthur H., Lieut., 2nd N. Durham Mil.
Baillie, F. H., Lieut., 60th Royal Rifles.
Richmond, H. T., Major, Staff Officer of Pensioners.
Templer, C. B., Lieut., late Indian Navy.
Maude, F. F., V.C., C.B., Col. late 3rd Buffs.
Berkeley, Robert, Captain, 29th Regt.
Colville, Hon. W. J., Col. late Rifle Brigade.
Hamilton, Mark, Esq., M.D., B.A., Surgeon, R.N.
Gray, William, M.P., Lt.-Col., 27th Lancashire Rifle Volrs.
Stewart, Hon. R. H., Capt. late 42nd Highlanders.
Troyte, Charles A. W., Major, 1st Devon Rifle Volrs.
Briggs, David, Lt.-Col., Bengal Staff Corps.
Chapman, J. F., Capt., 7th Dragoon Gds.
Toler, James O., Lieut., 74th Highlanders.
Simpson, Charles H., Lieut., 74th Highlanders.
Cureton, E. B., Col.-Commandant, Canterbury.
Harran, Edward, Capt., 4th Drag. Gds.

NAVAL GUNS.

By Commander Wm. Dawson, R.N.

> . . . "instrument to plague the sons of men
> For sin, on war and mutual slaughter bent."
> Milton.

Under many conditions of battle, as ships are at present equipped, the stem, whether employed to run into high-sided or to run over low free-board vessels, would occupy the foremost position. But artillery would even then fulfil an important, if subordinate part. There are, however, many conditions of maritime war in which these positions would be reversed, and many others in which the result must be decided exclusively by artillery. Should offensive torpedoes be introduced as an essential portion of future naval armaments in all classes of ships, it will become so mutually dangerous for vessels to approach each other for ramming or over-riding, that the guns may be expected to resume their old position as the principal arbiters of naval combats. In whatever light, then, we regard the newer and more annihilating weapons, it will be seen that, for many most important purposes of maritime war, there is ample room for the fullest development of artillery science. Pitched battles between ships and guns of precisely the same type cannot be regarded otherwise than as most exceptional; and it is most unlikely that special types of vessels will generally be at the right spot to do the particular work for which they were designed. Even in fleet actions, who shall say that the varying classes of ships will always be distinguishable, or will single one another out for attack; and that the wooden ship shall not run over the low freeboard monitor, the iron clad be pitched into by the gun vessel, &c., &c.? It seems then undesirable that the offensive powers of individual ships should be limited to those necessary for penetrating the least vulnerable parts of similar vessels. There is, in short, no necessary relation between the armour and the armament of given ships. Most ironclads, for example, are seriously damageable, if not destructible, outside their armour plating, and that by non-plate piercing weapons. Bombardments may be very effectively aided by non-plate piercing guns. Gunboats and torpedo vessels, which may destroy the stoutest ironclads, are themselves destructible by similar "light" artillery.

A consideration of the manifold uses to which ships of war may be applied, and of the many vulnerable points in hostile ironclads, leads me to doubt the wisdom of reducing their offensive powers to that of a few heavy plate-piercing ordnance. In our recent constructions many destructible portions have been lopped off, in that respect strengthening the defence, but increasing materially the danger of being over-ridden and leaving no space for carrying non-plate piercing guns. The defensive qualities gained by the removal of the topsides, appear to be compensated by the increased liability to be over-ridden; whilst the offensive power is greatly reduced by the impossibility of carrying "light" artillery outside the armour plating.

In the admirable paper on "the Attack and Defence of Fleets," by Captain P. H. Colomb, R.N., in No. 64, Vol. xv., of the Journal of this Institution, the experimental gun-practice made by the "Hercules," "Captain," and "Monarch," at a rock off Vigo, as well as the prize firing of a ship in the Channel squadron, is carefully analyzed; the former Flag Captain of that squadron, Captain J. G. Goodenough, R.N., concurring in the analysis. In that paper, Captain Colomb points out that the artillery powers of modern ships have decreased immensely as against similar vessels, as compared with that of the old wooden ships against the vessels of that period; and that this decrease of effective gun-power is proceeding rapidly with every improvement of the art of defence. Summing up his investigation of almost the only recorded practical naval gunnery experiment bearing on this point, Captain Colomb concludes, that "in six minutes from the opening "of the 'Monarch's' fire on the sister ship at 1,000 yards, she "will have fired 12 shot, of which one will have hit and another "may have glanced, and it remains an even chance whether the single "hit will have penetrated the enemy's armour." A single hit, the penetration of which is doubtful, is all that one of our most powerful ironclads can effect in the six minutes which a similar ship would be under fire whilst running down to ram or torpedo. Captain Colomb complains, with much reason, of the absence of exact corroborative experiment, or, if such exists, on the secrecy with which it is withheld from the service, as to the number of useful hits to be anticipated in an artillery combat between moving vessels. He points out the fallacy of trusting to observations taken from the masthead, or from the extremes of the vessel firing, and the absolute necessity for experiments being exactly recorded by observers nearly at right angles to the range, if any reliance is to be placed on the record. In determining the absolute values of rifled armaments, we are, in the absence of such exact information, reasoning without premises. If we are to believe the reports of artillery fire at sea, with lively motion and at unknown distances, as made by observers in the same ship, it is far more accurate than that which takes place from an immovable platform, at well ascertained distances, by accomplished gunners at Shoeburyness. The publication of such absurdities might lead to more correct modes of observation.

As to mere rapidity of fire, when aim is not required at a small or moving object, and no alteration of step is required, each of the "Monarch's" four 25-ton turret guns can fire one round every 2′ 10″. A recent experiment was made, in firing four rounds, with battering charge and shot, at widely different distances:

1st. Horizontal, on centre step.
2nd. 3° depression, on top step.
3rd. 14½ elevation, on lowest step.
4th. Horizontal, on centre step.

The intervals of time between the shots were:—

	3rd gun.		4th gun.		5th gun.		6th gun.	
2nd round	2′	40″	3′	20″	3′	0″	3′	20″
3rd "	2	26	2	40	3	10	2	10
4th "	2	34	2	35	2	45	2	30
Total time	7	40	8	35	8	55	8	0

The training, elevating, compressing, and hydraulic-arrangements seem to be all that can be desired for 25-ton turret guns; their smooth and regular action contributing largely to accuracy. But the arrangements for ascertaining the distance, and for loading, are susceptible of great improvement.

Recent Australian newspapers gave very loose records of two days' shooting by the low freeboard breastwork monitor "Cerberus," a colonial defence ship of the new construction mounting four 10-inch 18-ton turret guns. Eleven shells were fired in two days' deliberate shooting at unknown distances supposed to vary from 2,500 to 3,700 yards. Of these, three were supposed by those on board to have fallen near the target,—how near, it was, of course, impossible to observe,—and only one burst. As no observations were taken at right angles to the range, there are no means of knowing whether the "Cerberus" (one of our most recent constructions) would have made a single hit at a penetrating angle during her two days' shooting. But, so far as the record goes, it shows that the practice of the "Hercules," "Captain," and "Monarch," on which Captain Colomb relies, was conducted under exceptionally favourable conditions, as to knowledge of distance and as to skilful gunners. One effective shot out of twelve is then all that may be expected, even from a ship with masts from which to measure the distance, and in cool shooting at a fixed object of her own size. How all important, then, that this one projectile should strike end on, penetrate the armour, and explode a capacious bursting charge! If this one hitting shell break up before reaching the object; or, wabble along the bore, or fly "noisily" through the air, and then go flop, broadside on, against the hostile ship, twelve discharges would be thrown away for every such mishap; and thus for twelve minutes the "Monarch," with her four 25-ton guns, or the "Devastation," with her four 35-ton guns, though firing most rapidly, and making a great noise and much smoke, would be most helplessly inoffensive. Similarly the "Glatton," with her two 25-ton guns, would, by such a break up or "noisy" flight of the one hitting projectile in twelve, be reduced, not to silence, but to inoffensiveness for twenty-four minutes; and the "Hotspur," though of 2,637 tons, with her one 25-ton gun, would be harmless for 48 minutes. Surely, then, there is great need to cultivate in naval gunnery a scientific exactitude of observation, of record, of practice, and of study which has hitherto been foreign to the profession. It is only by such close research into details, practical and theoretical, that we can hope to discover the means of securing a larger percentage of hits, followed by useful penetration. That illiterate impatience of exact science which has in all ages distinguished the so-called "old school," ought to be set aside, now that scientific appliances permeate every part of the seaman's art, and ships are not only propelled but steered by steam and hydraulics; guns handled by beautiful hydraulic and other machinery, and fired by electricity; economical navigation assisted by meteorological studies, and ignorance no longer regarded as the essential handmaid of seamanship. Whether it is possible to secure better results from our heavy ordnance is worthy of careful investigation:—1st. As to shell not breaking up prematurely. 2nd. As to their not wabbling in the bore, making a puffing "noise" in their flight, and striking broadside-on instead of end-on. 3rd. As to improving the shooting by a better system of sighting and by greater attention to rapidly ascertaining and communicating the ever-varying distance.

Three Classes of Naval Guns.

Naval guns may be divided into three classes:—

(*a.*) *Small or Boat Guns*, of which there are about nine natures, some breech, some muzzle-loaders, some smooth-bore, some rifled, some of wrought iron, some of steel, and some of brass. All the rifles are grooved with an uniform spiral, those for the breech-loaders being multigroove with lead-coated projectiles, and the muzzle-loaders having three deep wide "Woolwich" grooves for two rings of studs. Of these, the breech loader offers many advantages for working in the confined space of the bow of a boat, though as military men prefer muzzle-loaders for field pieces, our newest boat guns are of this nature. The superior accuracy which rifled guns afford when fired from a steady platform at known ranges is quite thrown away when firing from the lively bow of a pitching boat at unknown distances. This inaccuracy is greatly increased as regards the Armstrong breech-loaders, by the extremely small distance between the rear sight and fore sight, which renders a finely-graduated tangent-sight valueless. Muzzle-sights have been, however, restored in the new muzzle-loaders, and if some means were practised for ascertaining the distance, the shooting would be greatly improved. The essential importance for sea practice of a long radius between the sights may be illustrated by the trunnion sights of the 20-pr. 13-cwt. breechloader—a visual error of half an inch vertical when firing at an object 1,000 yards distant, would make about 300 yards difference in the range, whereas, by substituting a muzzle-sight, it would make about one-half or 150 yards. The length of 1° on the tangent-sight is about two-tenths of an inch for every foot of radius between the sights. The bearing which additional length of degrees on the tangent-scale has upon shooting is not evident when aiming from a steady rest with the eye close to the rear-sight; but the more lively the platform, and the further the eye is from the rear-sight, the more essential does it become to reduce the effect of unpreventible visual errors. Every foot gained between the sights admits of an additional ·2 inch of vertical visual error without any increase of inaccuracy in the shooting. This applies with equal force to all guns on shipboard, most of which would give one or two feet increased radius, *i.e.*, two-tenths or four-tenths of an inch compensation for visual errors, without interfering with the ports. All refinements of rifling, or of graduations in sights for increased accuracy, sink into insignificance when shooting with lively motion at sea, before this large preventible source of error.

(*b*.) "*Light*" *Guns.*—Second, comes the class of "light" guns, including nineteen varieties under six tons weight, most of which are ready to follow the numerous other obsolete weapons of similar weight which have been removed from the effective list. Some of these are wrought iron guns, of the Armstrong breech-loading pattern, about the disposal of which there is some difficulty. Others, however, like the cast iron 68-pr. of 95 cwt., the 8-inch gun of 65 cwt., and the 32-prs. of 56 cwt. and 58 cwt., cannot be parted from without a pang. Their best friends can hardly regard with satisfaction their conversion, at great expense, into rifled ordnance, by reaming them up, thus weakening their breeches, and inserting wrought-iron tubes of doubtful longitudinal strength.* By this device we obtain 150 doubtful mixed cast and wrought-iron guns for the same money which would work them up into one hundred perfect wrought-iron guns of the most approved Fraser pattern. We want at least one "light" wrought-iron rifled gun of about four tons weight for general use; but it is most undesirable to multiply weights and calibres in this class. A uniform spiral and two rings of studs, with French (Woolwich) or "shunt" grooves, are used in all these light muzzle-loading guns. But no new guns are being rifled on the "Shunt" system, as the studs overrode the grooves, owing, in some degree, to the loose fit in the bore, except at the muzzle-nip.

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* See Report of Ordnance Select Committee, dated 16 March, 1868, page 8

The Americans, who have a large stock of heavy smooth bores on hand, and are desirous of possessing rifled ordnance, do not contemplate the adoption of this system of conversion. The 23 Parrott guns, which, out of 42, blew their own muzzles off at the siege of Charleston, were of this compound material, the wrought iron being outside; and, though the bursting was no doubt accelerated by the increasing twist given to the grooving, as reported by General Gilmore, yet the Chief of the Ordnance Bureau reports to Congress, June, 1871, that "Cast "iron is not believed to be suitable for heavy rifled guns; other material "should be experimented with."

These guns are largely used in small vessels. They are badly mounted on primeval truck carriages which work by jerks, causing great inaccuracy, and employing as many men as the 12½-ton guns.

(*c.*) "*Heavy*" *Guns.*—The third class, or "heavy" guns, consists of all ordnance above 6 tons weight, of which there are at least eight different natures. The contest between guns and armour has led from time to time, to such developments in the conditions of both, that we are fast getting into a mess of calibres and weights, calling for the elimination of already obsolete weapons from the effective list. This mess may be further heightened by the great number of varieties in the projectiles, so that the "heavy" ordnance may soon have to be sifted and reduced to three, or at most four natures, and the projectiles for each reduced from six to three, or at most four, kinds. As it is on the "heavy" guns that we must place our chief reliance in future artillery combats, it may be well to consider them more in detail.

Foreign Navies.—Before proceeding to discuss our own weapons, it may be interesting to glance at the heavy armament of foreign navies. With regard to the calibre of their naval guns, England and the United States stand first, but the 20-inch Navy 1,000 prs. of 44½ tons with 100 lb. charges, of the latter country, are relatively so inferior in effect to the rifled guns of other states that hardly any comparison is possible between them. England, on the other hand, possesses in its 10-, 11-, and 12-inch muzzle-loaders, the makings of effective guns, which fire, with imperfect rotation, projectiles of 400, 530, 600, and 700 lbs. in weight, with charges of 70, 85, and 100 lbs. of powder. The heaviest French 10·8-inch gun fires a projectile of 475 lbs., for which a charge of 79 lbs. of powder is required. The heaviest Danish gun is an 11·24-inch muzzle-loader, with a projectile of 462 lbs., and a charge of 66 lbs. of powder; Denmark has also 9- and 10-inch muzzle-loaders, with projectiles of 311 and 400 lbs. Holland has only got so far as a 9-inch gun for its marine artillery. The heaviest Italian gun is a 10-inch muzzle-loader, with a projectile of 400 lbs. weight, and a charge of 60 lbs. of powder. Austria still retains her 8- and 9-inch guns. The German Navy intends to adopt 10·238 and 11·05-inch Krupp steel breech-loaders, with lead-coated projectiles of 411 and 513 lbs., and charges of 70 and 88 lbs. of powder respectively. At present, however, its heaviest guns are 8- and 9-inch breech-loaders. Russia has already adopted the 11-inch Krupp breech-loader. Sweden and Spain have as yet no heavier gun in their navy than a 9-inch breech-loader, with a projectile of 316 lbs., and a charge of 52 lbs. of powder. The Krupp steel breech-loaders have been adopted by Germany, Russia, Belgium, and Austria; the latter State has also some Armstrong muzzle-loaders. The French breech-loading system has been adopted by France, Holland, Spain, and Sweden. In Sweden, however, the mode of construction is peculiar to the country, and the guns are made of cast-iron. The English Armstrong "Shunt," and the French or "Woolwich" muzzle-loaders have been introduced in the English, Italian, Danish, and (to a certain extent) Austrian Navies. Bronze guns of large calibre have not been adopted by any State, though experiments have been made with them in the North German Navy, and the "Arminius" was at one time armed with 8-inch guns of this material. As for the powder employed in heavy guns, the English "pebble" and "pellet" have hitherto only been used by England, Holland, and Italy. In the Russian, Belgian, and Austrian Navies "prismatic," and in the United States "Mammoth" powder is used; while all the other States still employ the ordinary powder. It is believed, however, that the French and Swedish Navies will shortly adopt the new kinds of English powder. The Committee on explosives state, May, 1871, that "the Russian 11-inch "breech-loading gun of 25 tons, fires a battering charge of 82 lbs. of "prismatic powder, giving a muzzle energy of 185 foot tons per inch "of the shot's circumference, whereas our 25-ton muzzle-loading guns "were only intended to fire battering charges of about 70 lbs. rifle "large grain, giving a muzzle energy represented by about 160 foot "tons per inch of shot's circumference." With 85 lbs. of pebble powder our 25-ton guns give a muzzle energy of 187 foot tons per inch of shot's circumference. No navy appears to have overcome the difficulties of working these ponderous weapons with perfect safety, uniformity, accuracy, and ease in a seaway, except our own, and those which have copied from us. Rodman and Ericcson have exhausted talent and ingenuity in resolving this problem for the United States, but though that country had many years' start of us in handling heavy guns, the Chief of the Ordnance Bureau states, in his last report, that "a large "sum is required for alterations in the 10- and 15-inch iron gun carriages," which have to be re-made. To Captain R. A. E. Scott, R.N.,'s ingenuity we owe it that 12-ton, 18-ton, and 25-ton guns are now being worked on broadsides and in turrets. Four men can work the 25-ton gun on the "Hotspur's" broadside, at sea.

Construction of "Heavy" Guns.

Cast-iron Guns.—As is well known, the Americans construct their large smooth-bore guns of cast-iron, in the manipulation of which material they have attained rare excellence; but their Chief of the Ordnance Bureau reports that "it is thought that a still further im"provement may be made by a change in the treatment of the metal "in the furnace, and experiments with this object in view are now "progressing." He, moreover, agrees with us, that "cast iron is not "believed to be suitable for heavy rifled guns." Comparing guns of nearly similar weight, we find that the American 15-inch Rodman of 19½ tons, firing a shell of 453 lbs. weight, containing 17 lbs. bursting charge, performs 62 foot-tons "work" per inch of the shot's circumference at 1,000 yards; whilst the English 10-inch 18-ton gun, firing a shell of 400 lbs. weight, containing $9\frac{1}{4}$ lbs. greater bursting charge, performs 61·3 foot tons more "work" per inch of circumference at the same distance. Taking then, the weight of gun, bursting charge of projectile, and "work" per inch of its circumference as a criterion, the English-built rifled guns have, at 1,000 yards range, greatly the advantage of the American cast-iron smooth-bore ones.

Steel Guns.—The only other material largely used in the manufacture of heavy ordnance, besides our own, is the Krupp steel. The Krupp guns are breechloaders, provided with lead-coated projectiles, squeezed through numerous grooves which are gradually reduced in size towards the muzzle sufficiently to make amends for the compression or wearing away of the lead coating in its progress along the bore. This ensures the perfect centering of the shot throughout the bore. Steel guns are more than double the cost of wrought-iron ones. Taken weight for weight, steel is generally stronger than wrought-iron; but in the block form it is subject to the uncertain endurances of all castings, and cannot be relied on for uniformity of strength, or for withstanding dynamic shocks. The limits of elasticity under static pressures, or that at which, if exceeded, the metal would fail to resume its form; and the breaking weight per square inch, with good specimens as tested by the machine at the Royal Gun Factories, are:—

	Limits of elasticity per sq. inch.	Breaking weight per sq. inch.
Cast-iron	4 tons	10 tons.
Wrought iron across the fibre	Same as above.	
Wrought iron, in the direction of its fibre	12 tons.	25 tons.
Steel	13 ,,	31 ,,
Steel toughened in oil	30 ,,	45 ,,

The brittle character of steel rendered its manufacture in blocks difficult when required to sustain dynamic shocks, but built guns have been more successful.

Moreover, when block steel guns do burst, they frequently do so explosively, dealing death and destruction to all around; whilst wrought iron guns generally, except when the shot jams, give timely warning of approaching dissolution. Thus, the jamming of shot and the violent bursts of wrought iron coil guns have, happily, not yet resulted in killing or wounding their friends, but we have detailed accounts of the bursting of 24 block steel guns, four being attended with loss of life. Of these, six field guns burst on service during the Prusso-Austrian campaign; another killed three Prussian cadets; another killed the Director of Prussian Artillery and a gunner; whilst the naval part of the suicidal fatality is represented by a 9-inch gun, which, bursting whilst at target practice on board the Russian frigate "Alexandra Nwsgi," killed twelve officers and men, wounded thirty, and seriously damaged the ship. Such a calamity would assuredly decide the fate of any seriously contested naval action. We have no account of any failures during the late Franco-German war.

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CAMPBELL'S RANGE INDICATOR

Fig. 1.

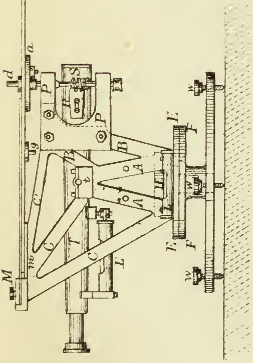


Fig. 2.

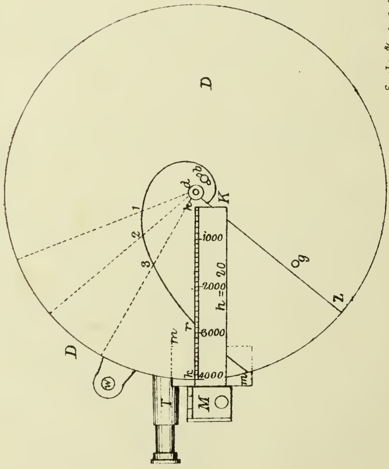


Fig. 3.

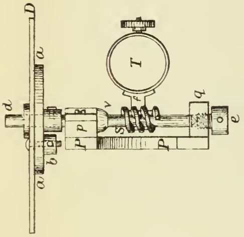


Fig. 4.

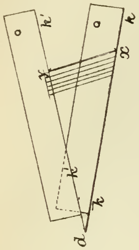
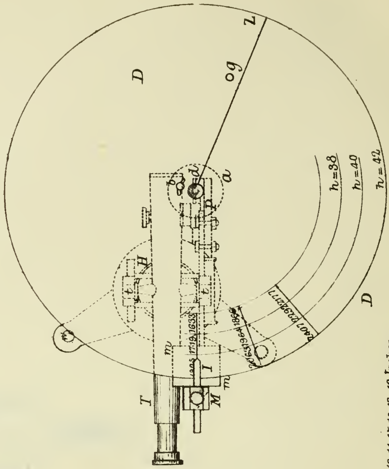
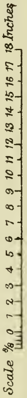
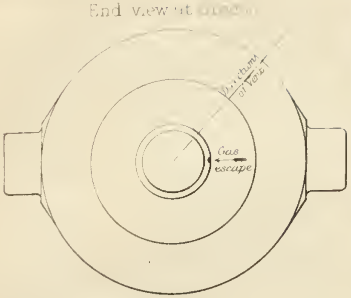


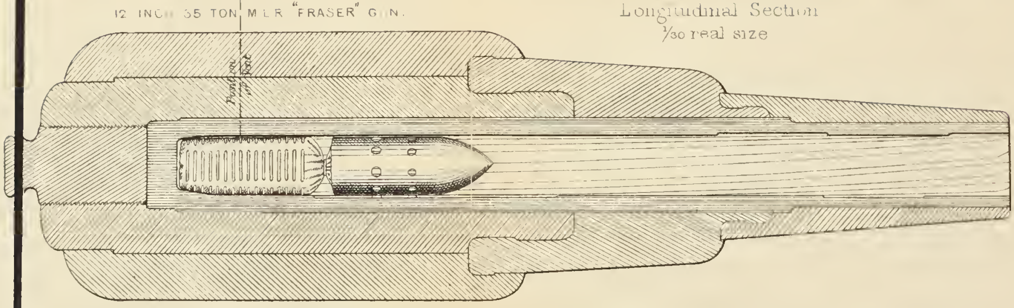
Fig. 5.



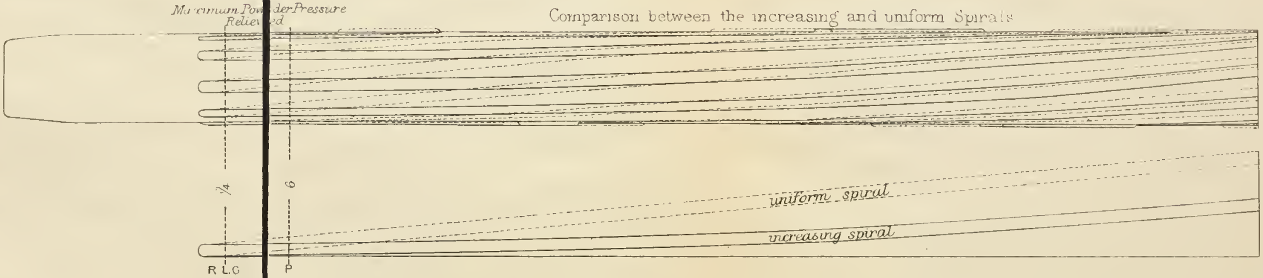


J.Jobbins





Section of Bore
1/10 real size


Maximum Powder Pressure Relieved
Comparison between the increasing and uniform Spirals
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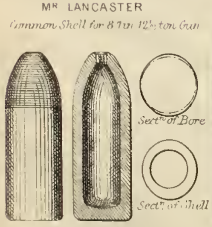
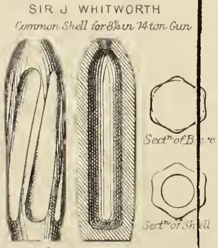
6
uniform spiral
increasing spiral
R.L.G.
P



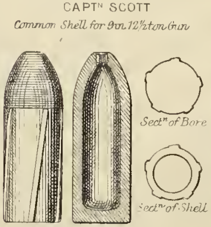
MR LANCASTER
Common Shell for 8·1 in 12½ ton Gun

Cast Iron 232 lbs
Powder 18
Total 250



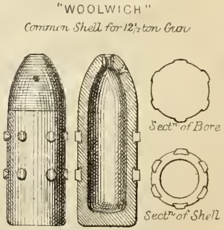
SIR J. WHITWORTH
Common Shell for 8¼ in 14 ton Gun

Cast Iron 291 lbs
Powder 19
Total 310



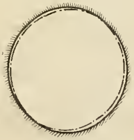
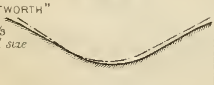
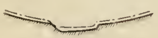
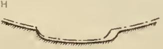
CAPTN SCOTT
Common Shell for 9 in 12½ ton Gun

Cast Iron 232 lbs.
Powder 18
Total 250



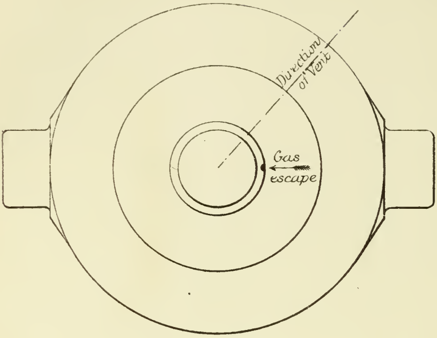
"WOOLWICH"
Common Shell for 12½ ton Gun

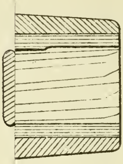
Cast Iron 232 lbs
Powder 18
Total 250

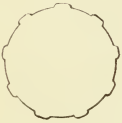
System Rifling in bearing, Shot passing out	Calibre	Number of Grooves	Width of Grooves	Depth of Grooves	Metal removed pr foot of Bore
					lbs
"LANCASTER" 12th real size 	8·705"	2	8·705"	·328"	15·66
"WHITWORTH" 1/3 real size 	8·25"	6	3·3"	·4"	16·9
"SCOTT" 1/3 real size 	9"	5	·8"	·125"	1·39
"WOOLWICH" 1/3 real size 	9"	6	1·5"	·18"	4·9

J. Jobbins

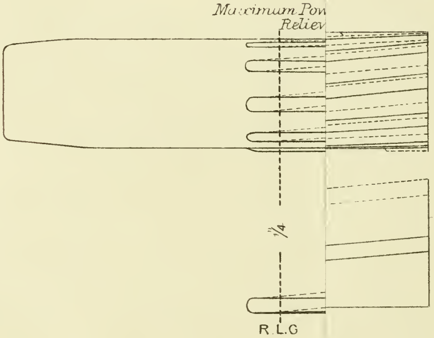
End view at Breech



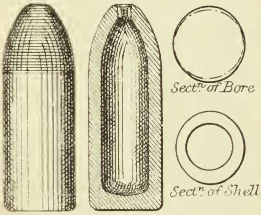




Section of Bore
1/10 real size

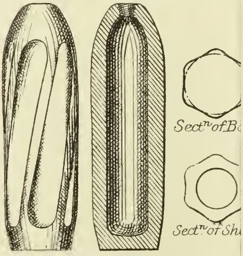


MR LANCASTER
Common Shell for 8·7 in. 12½ ton Gun



Cast Iron 232 lbs
Powder 18
Total 250

SIR J. WHITWORTH
Common Shell for 8¼ in. 14 ton Gun



Cast Iron 291 lbs.
Powder 19
Total 310

Depth of Grooves	Metal removed pr foot of Bore
	lbs.
·328"	15·66
·4"	16·9
·125"	1·39
·18"	4·9

J. Jobbins

Block Steel Guns burst.

Date.	No. of guns.	Calibre.	Nature of steel.	Rounds.	Place.	Men killed.	Men wounded.
June, 1860 ..	1	12 pr.	Mersey	6	Shoeburyness	—	—
June, 1861 ..	1	VII in.	Mersey	16	Shoeburyness	—	—
Nov., 1861 ..	1	20 pr.	Krupp	2	Shoeburyness	—	—
March, 1862 ..	1	30 pr.	French	..	Gavres	—	—
April, 1863 ..	1	20 pr.	Muskets	132	Shoeburyness	—	—
August, 1865 ..	1	9¾ in.	Krupp	..	Prussia	—	—
1864 ..	1	9½ in.	Krupp	66	Russia	—	—
1865 ..	1	8½ in.	Krupp	109	Russia	—	—
1866 ..	2	Field	Krupp	..	Sadowa	—	—
1866 ..	4	Field	Krupp	..	Prussian War	—	—
1866 ..	1	Field	Krupp	..	Berlin	3 cadets	—
June, 1866 ..	1	IX in.	Krupp	56	Russia	—	—
Jan., 1867 ..	1	VII in.	Krupp	2	Woolwich	—	—
27 Sept., 1867 ..	1	4 pr.	Krupp	..	Tegel, Berlin	2	—
July, 1867 ..	1	IX in.	Krupp	..	Russian frigate, “Alexandra Nwsgi”	12	30
Nov., 1867 ..	1	7·6 in.	French	..	Havre	1	—
1868 ..	1	IX in.	Krupp	..	Russia	—	—
1868 ..	1	IX in.	Krupp	..	Cadiz	—	—
Jan., 1869 ..	1	VIII in.	Krupp	..	Prussia*	—	—
29 Sept., 1871 ..	1	XI in.	Krupp, hooped	1	Cronstadt†	—	—

Were it not for the fatalities, these failures would not be remarkable, being less numerous than those of wrought iron guns destroyed by their own rifling. Nor do they affect the question of built or hooped steel guns. In the hooped steel gun which burst at Cronstadt, in 1871, it was the unhooped chase which gave way.

Wrought Iron Guns. (Plate XII.)—English guns are, as is generally known, built up of wrought iron coiled tubes, shrunk on over a steel inner tube, the general principle of which construction was originally introduced by Sir William Armstrong. Great improvements have been introduced into the system of manufacture under the auspices of the authorities of the Royal Gun Factories. Under Colonel Campbell's able guidance, Mr. R. S. Fraser, C.E., the Assistant Superintendent, has given great additional strength to guns:—1st, by the substitution of cheap, soft, scrap iron, of great tenacity, for that of an expensive hard iron, of great tensile strength, the latter property giving a brittle character, well calculated for the endurance of static pressures, but unequal to resist the dynamic forces, to meet which the more yielding soft iron is better designed; 2nd, by the reduction of the number of parts, and, therefore, of the number of welds and shrinkings in building the gun. Whilst the old construction consisted of fifteen to twenty-three parts, according to the calibre; the Fraser gun consists of four to six parts only. The Fraser coils are made of bars of greatly increased size proportioned to the weight of the gun, which are twisted one or two deep round a mandril (each riding turn breaking joint with the one below), and are then submitted to the hammer; 3rd, by changing the direction of the fibre in the breech piece, from that of a longitudinal forging of bars, to a transverse coil, adding greatly to the power to resist bursting strains around the powder-chamber. The steel tube is toughened in an oil bath, and is intended as a hard lining to receive the grooving, and, being less easily fused, to bear the erosion of the gas escaping from the powder-chamber, as well as to prevent the gas penetrating into imperfect welds, and to withstand the studs of the projectiles, which are found, when iron or bronze lining is used, to "upset" and bur the grooves rapidly and to bruize the bore so as to prevent, after a short time, the entrance of the shot.

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* Into twenty pieces.

† Into several pieces.

The relative cost of the several constructions is :—

	£	
Cast iron guns	21	per ton.
Armstrong, wrought iron coils ..	100	,,
Fraser, cheap iron	65	,,
Krupp's, or Whitworth's steel ..	170	,,
Gun-metal	190	,,

The steel lining can be patched when slightly injured by its own projectiles; whilst it can be altogether replaced, at a cost of about £700 in the largest gun, when worn out or cracked by them. The cracking of the toughened steel lining does not necessarily disable the gun, so long as the shot can be entered. The injury is arrested when it reaches the wrought iron coil in which the strength of the gun resides. Thus, the 35-ton gun had its steel inner tube cracked in the lower groove near the seat of the lower stud, after firing about 3½ tons of various gunpowders, with charges varying from 75 to 130 lbs., and 21 tons of projectiles, each weighing 700 lbs. The gun is still fit for work; whilst the Krupp steel 11-inch gun, which burst at Cronstadt on the 29th September last, at the first round, with 90·92 lbs. prismatic powder and 496·54 lbs. projectile, had its unhooped muzzle scattered into several pieces, the built part alone remaining on the carriage. The cost of the Krupp steel gun was £6,000, whilst that of a similar wrought iron one is about £2,500. The weak point of our present construction is the necessity for employing a steel lining. When the gun is heated by continuous heavy firing, an unequal expansion takes place, depriving the highly elastic oil-tempered steel lining of the intended support from the ductile wrought iron coils. There is great difficulty, however, in finding a better lining material which will withstand the concentration of rotary effort upon a small bearing, and which will not easily fuze or erode under the high temperature developed during the consumption of the charge, and which will yet expand simultaneously with the coils. The problem may be safely left to the untiring diligence and scientific talent displayed by the Director-General of Artillery and the manufacturing Superintendents at Woolwich, and other members of the Artillery Corps, to whose unsparing devotion and intelligent zeal, the country is deeply indebted for the high position its ordnance-manufacture has attained amongst all the civilized nations of the world.

Requirements in a Naval Gun.

In comparing different systems, it must be remembered that the elements of rifling are at least six in number, and admit of various combinations. The form of the bore; the form of the grooves; the number of grooves; the twist; the proportion of the weight of the elongated shot to that of a round ball of the same calibre, or, in other words, the calibre for a given weight of projectile, and the weight of projectile for a given calibre; the nature and arrangements of the studs, ribs, or other agency by which rotation is effected.

Colonel Owen, Professor of Artillery at Woolwich Academy, in his "*Modern Artillery*," classifies the conditions that are specially desirable in a system of rifling for military ordnance under five heads, of which the first is "accuracy of fire," and the last "to allow of the use of large charges," or endurance. We have no Professor of Artillery at the Naval College, as theoretical instruction does not form part of the naval gunnery course, but the late Director-General of Naval Ordnance has left on record a classification of six wants in a good naval gun, of which the first is endurance and the fifth accuracy; thus reversing the military classification. Both authorities are right. To the Army, extreme accuracy in the gun is most valuable, and can be realised in practice; whilst the breaking up of a projectile is only a nuisance, and the disabling of a gun a remediable evil. But to the Navy, the breaking up of a hitting shell may seriously affect the results of an action, and the disabling of a gun decide the engagement unfavourably; whilst, as to accuracy, Admiral Key says, "it is comparatively easy to " obtain it to such an extent, as is sufficient for purposes of naval war- " fare. Under the ordinary circumstances of a naval action, the pro- " bability of striking an enemy's ship, is dependent far more on an " accurate knowledge of the distance, on the steadiness of the ship " carrying the gun, and the skill of the man who fires it, than on the " qualities of the gun itself. Any of the systems of rifle ordnance " which have been tried with any degree of success, possess sufficient " accuracy for ordinary warfare. Indeed, it is highly probable that " the 100-pounder or 68-pounder smooth bore guns would strike the " enemy more frequently at 1,000 yards range and under, than the " most accurate rifled gun yet made, owing to the regularity of their " ricochet and low trajectory at short ranges." My experience confirms this, as I have found the 68-pounder, when used with a muzzle dispart, which doubles the radius for the tangent scale, shoot far better from a lively gunboat at 2,000 yards than rifled guns fired at the same time. The points which Admiral Key considers should take precedence of accuracy in a naval gun are enumerated by him in the order of their importance, thus:—

" 1st. Strength (to withstand heavy charges), endurance, and regu- " larity of construction.

"2nd. Penetrating power, at ranges up to 1,200 yards. It is "certainly the most important under the existing circumstances of "naval warfare. It is the most difficult to obtain, and without it all "other qualities are useless.

"3rd. The use of a powerful shell.

"4th. Simplicity as regards non-liability to derangement and facility "of working. Of all systems, the muzzle-loading smooth bore has the "advantage on these points: the gun without grooves or any working "parts, the shot without studs, and of such a form that it will roll "home of itself. The Woolwich or Service system retains the dis-"advantages of a grooved gun and studded projectiles. Owing to the "great improvement in gun carriages," exclusively due to the mechanical genius of Captain R. A. E. Scott, R.N., the late Admiralty Superintendent of Naval Gun Carriages, "the 9-inch gun of 12½ tons has "a great advantage in ease of handling over the 68-pounder of 4¾ tons, "being worked with fewer men, greater rapidity, and *far more security*;" a remark which applies now equally to the 18-ton, 25-ton, and 35-ton guns, all of which are mounted on Scott's broadside, turn-table, or turret carriages.

"5th. Accuracy, with a low trajectory, especially at ranges under "1,500 yards. The subordinate position occupied by the quality next "in order of importance, '*Accuracy*'" has already been explained.

"6th. Extensive range . . . for special purposes will prove of "considerable value; the circumstances under which the increase of "range will be found necessary will, however, be of rare occurrence. "This quality is, therefore, not a *necessity* for naval ordnance . . . "When, however, it is found that the great range of rifled guns is "combined with many other valuable qualities, it may be accepted as "an increase of efficiency which adds to their value."

Following the principles so admirably enunciated by the late Director-General of Naval Ordnance, I dismiss from present consideration such small differences as may exist between the various rifle systems in extent of range and in accuracy beyond 1,500 yards, and would direct attention to the four more essential points, as affecting:—

1st. The endurance of the gun and strength of the projectile.

2nd. Penetrating power up to 1,200 yards, as measured by the initial velocities of similar shot.

3rd. The use of a powerful shell.

4th. Simplicity as regards non-liability to derangement in the gun and in the projectile.

Many able artillery officers are dissatisfied with the present system of rifling, which was copied from the French. These experienced artillerymen point to the failure to rotate long-shell; to the breaking up of projectiles owing to the concentration of rotary effort on a small weakening ring of points; to the enormous loss of shell power in heavy guns; to the abrasions of the bore by the hammering action of the projectile; to the erosions of the upper portion of the bore aggravated by the deep wide grooves; and to the consequent lack of endurance of heavy guns and their projectiles, as well as to the irregular "noisy" flight of the latter; and they tell us that "a better system might be found."

*Four Systems of Rifling.**

Turning, then, to those systems of which official experience has been had at Shoeburyness, we find that lead-coated projectiles can only be employed in breech-loading ordnance.

Lead-expanding, as distinguished from lead-coated projectiles have proved unsuitable for heavy charges, the lead being blown off to the danger of friends, and the shots flying wild to the comfort of enemies. Of the various plans proposed for rifling muzzle-loading heavy ordnance, we have ample official experience of four which deserve attention. Three of these systems agree in employing but one material in the projectile; in providing a long iron bearing, co-extensive with its cylindrical length, which diffuses the strain caused by the effort of rotation over a great surface, and in adopting a uniform angle of groove which impresses rotary motion on the shot from its first movement in the bore. The fourth system employs compound material, one part of which is soft metal, easily bruised; a short bearing of six-tenths of an inch, being the flattened curve of a circular stud, in each groove; and an increasing twist, which does not attempt to impart rotation until the projectile has proceeded some distance along the bore and attained a high velocity.

The Lancaster Oval Bore. (Plate XII.)—Of the long-bearing, one-metal, uniform-spiral systems, Lancaster's two-groove or oval-bored system is first in order. Successfully adopted in small arms with lead bullets, it was introduced into the service for heavy ordnance in 1853, and was used during the Russian war, with an increasing spiral, which caused the bursting of three gun-muzzles out of eight. Sir Howard Douglas, in his "*Naval Gunnery*," says, "on one occasion the whole " muzzle was blown off by the *increasing strain* put upon it; but having " got rid of this weak part, the gun continued to be used with safety " and effect as a howitzer." A uniform spiral was subsequently used and good results were obtained from several guns at Shoeburyness, but notwithstanding Mr. Lancaster's great experience and talent, and the frequent experiments since made, eighteen years' labour have failed to attain perfect success. The last attempt was made in 1869, a 10-inch 18-ton gun being bored up with two wide grooves, each one-third of the circumference in width, the shoulders of the grooves being shaved off so as to form an oval bore. After five rounds "the experiment was " stopped, as it was evident that the shot failed to attain the necessary " rotation," and the gun was "made into a service gun." The Lancaster system, so successful in small arms, has so much to commend it for great guns, by the simplicity of its projectile, and in a manufacturing light, that its non-success is much to be regretted. Yet it is evident that by shaving off the shoulders of the grooves, two circular wedges are formed, tending to burst the gun; and accordingly in the report of the 7-inch gun competition, 1865, we are told that "The Lancaster shells, with only one exception, were

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* As to past and foreign systems of ordnance and rifling, see Commander R. A. E. Scott, R.N.'s papers in the *Journal*, vol. v, No. 19, 1861; vol. vi, No. 21, 1862; vol. viii, No. 33, 1864; and Captain E. G. Fishbourne, R.N., C.B.'s papers, in vol. vi, No. 22, 1862; vol. viii, No. 30, 1864.

" found, on recovery, to be split in the head, showing apparently (as " has always been suspected) that in that system the projectile has a " great tendency to jam in the bore, bringing severe pressure both on " the gun and on the projectile." It was then " rejected on account " of the tendency to crush in the bore, evinced by the condition of the " recovered shells, its inferior accuracy (with shell), and the difficulty " of loading." To remedy these defects shewn in the 7-inch 7½-ton gun, alterations of form were adopted in the 10-inch 18-ton gun, which, as we have already said, led to failure. The two circular wedges which form the oval bore, however suitable to lead bullets in small arms, bring too great a strain on both gun and projectile to admit of that system succeeding.

The Whitworth Polygonal System. (Plate XII.)—Sir Joseph Whitworth's system has been before the world for seventeen years, and had the advantage of the great ability, energy, and experience of that great mechanician. It was the first to pierce armour-plating, both with steel shot and with steel shell, and has been reported upon by twelve Committees acting under the authority of five Ministers of War, and been experimented upon by able officers in this and many other countries, without, however, being adopted for "heavy" guns by any except Brazil. It consists of a polygonal, flat-headed projectile, of small diameter, to be projected from a steel or compressed metal gun, with a rear-vent and patent cartridges. The system thus embraces many distinct points, each requiring independent investigation, and some of which appear to be valuable, whilst others have not been sufficiently tested. Little is authoritatively known of the value of metal compressed—when fluid—in withstanding powerful dynamical forces; though the late Director-General of Ordnance records that "The " Secretary of State saw 1½ lbs of powder exploded in a closed cylinder " of 2½ inches bore, by means of a touch-hole of ·1 inch. The steel " seemed to be about 3 inches thick, and the powder completely filled " the chamber." Thirty-one 1½-lb. charges were exploded within this closed cylinder, with a total enlargement of ·1903 inch inside, and of ·0415 outside. A similar closed cylinder of cast iron burst into 30 fragments at the first explosion of 3 ozs. of powder, or one-eighth the charge used with compressed metal. And a similar cylinder of cast iron with wrought iron tube, like the converted 64-pounders, burst at the fourth explosion of 5, 6, 8, and 10 ozs. respectively, into 181 fragments, seven of which were of wrought iron. No similar comparison is recorded as having been made with ordinary steel or with projectiles. As the explosive power of a charge, as well as the inertia and friction of a projectile increase with their respective weights in a *cubical* ratio, whilst the surface of the chamber and of the base of the projectile, against which the force is exerted, increase only in a *square* ratio, the capability of compressed metal to withstand heavy explosions might be tested by its substitution for steel linings in a few heavy guns. The general principles with which we have now to do, are the polygonal rifling and the small bore. There can be little question that, other things being equal, the smaller the bore the better the penetration, so that if the one purpose to which guns were applied in war was the perforation of unbacked iron targets with neat, clean little holes, a small bore should be adopted. But the Navy wants to destroy its foes, not to punch neat holes of minimum dimensions; and we ask for shells of large capacity, which, by sacrificing a little of the refinement of penetration, may do the maximum amount of damage upon ships of ordinary construction. The sacrifice of penetration in adopting the service bore is comparatively little, whilst the gain in destructive capacity, in ordinary cases, is great. It is a question of compromise, and we adopt a reasonable mean between the spherical smooth bore of the American, and the long, narrow bolt of Whitworth. Thus the last 8¼ inch steel built gun of Whitworth's tried at Shoeburyness in 1870, and which, after firing 148 rounds, slightly cracked a moveable circular disc placed at the bottom of the bore, was 14½ tons weight, and threw a 310-lb. shot with a 40-lb. or 50-lb. charge. It is difficult to compare this with a 250-lb. projectile, thrown by a 43-lb. R.L.G. charge, from a 9-inch service gun of 12½ tons weight.

Sir Joseph Whitworth himself says, "In my system, with its comparatively small bore and large powder charges, and my cartridge, the "inner tube is no doubt severely tried. This is evidenced by the greatly "increased range and power, for which we have no doubt to pay a "high price in the shape of strain and wear upon the tube." Might he not sacrifice a little of range and accuracy, and bestow his attention to the other four points which Admiral Key enumerates as of greater importance? Why not apply the polygonal rifling in calibres similar to those at present in use?

The polygon has 24 surfaces, with six grooves, each ·4-inch deep, or three times the service depth, taking 16·9 lbs of metal per foot of bore out of the gun, weakening the gun in that proportion. Moreover, though the long iron bearing diffuses the strain over a large surface, and enables a rapid twist with great rotation to be given, yet the bearing is on a mere line in each groove and is much nearer the axis of the shot than in other systems, and the leverage for rotating is therefore much less. All iron-bearing systems rely on a mechanical fit, so that whatever advantage the polygonal system receives from Sir Joseph's great mechanical skill, can be equally imparted, under his leadership, to other iron-bearing systems.

The simplicity of material as to the shot in employing only one metal in its construction, and its incapability of injury by rough handling are such manifest advantages, that Sir Joseph Whitworth has always had the best wishes of many practical soldiers and sailors, who know the value of these qualities in the rough game of war. The late Director-General of Naval Ordnance classes the Whitworth system as first in point of "simplicity," as "the shot has no studs, and the gun no working "parts;" whilst Sir Joseph says, "owing to the absence of studs, and "to the simple form of my shot or shell, I am able now to fire them "just as they leave the mould." "The cost of wages for grinding, "drilling, punching, and finishing the large studded projectiles is many "times greater than for those of the polygonal system; the cost of the "metal for studs is also considerable."

Sir Joseph's argument is unanswerable when he says "For a 9-inch "polygonal projectile, the rifled surfaces which both support and "rotate the shot, have an area of 187 inches." Whilst "the 12 studs "of the 9-inch Palliser projectile have a circumferential area of 18 "inches for supporting the shot, but the area of the sides of the six rear "studs, by which the rotary motion is given, is only 1·6 inch. No prac-"tical engineer would think of providing so small a surface to give even "a small amount of rotation to a body weighing 250 lbs., much less "when the rotation of the shot at the muzzle of the gun has to be at "the rate of about 2,400 revolutions per minute. The increasing "pitch, which has been adopted, prevents the use of more than one "stud in each groove for giving rotation. This varying the curve is "the worst possible mode of imparting rotation, for each rear stud can "only bear against the side of the groove of the gun on a line of its "surface, on account of the ever-varying curve, except by excessive "pressure, which jams and distorts the soft metal, and occasions "liability to accident. The greater the amount of windage, the greater "will be the liability to accident."

The long iron-bearing system is so manifestly right in principle, and the short soft-bearing one so evidently wrong, that the Whitworth means of applying the former is likely to be warmly advocated so long as the latter obtains.

The Scott centering strengthening flange. (Plate XII.)—The third long iron-bearing system, with one simple material in the projectile, and uniform spiral in the gun, is that of Captain R. A. E. Scott, R.N., a distinguished pupil of the "Excellent." This differs from the preceding two, and from the present service system, in that it takes much less strength out of the gun in cutting the grooves; adds, by its long iron-flanges, strengthening buttresses to the walls of the shell; centres the projectile in the bore so that the two axes correspond as when firing lead bullets; enables a shell of maximum capacity to be thrown; gives the greatest leverage for rotation from the centre of the shell to the extremity of the flange, and presents, in cross section, a deep bearing surface.

The advantages of this grooving, as to the gun, are that, whilst using the service calibre, it would have:—

1st. Few, narrow, shallow, rounded grooves, of the same size for all guns.

Three grooves for 9-ton guns and under; 5 grooves for 12- and 18-ton guns; and 7 grooves for 25-ton guns and upwards; as against 4, 6, 7, and 9 grooves respectively in the service guns. Width ·8 inch each groove, as against 1·5 inch in the service gun; making in the 25-ton guns a width of 5·6 inch surface removed instead of 13·5 inches.

The Ordnance Select Committee reported in 1863, of the 32-pounder gun thus rifled, that "the plan which leaves the largest portion of the "cylinder untouched will be the best" in firing round shot, and that the proportion of windage added to the spherical shot by the grooving in that gun, by the Lancaster system was 2·955 square inches; in the French (or Woolwich) gun 1·36 square inches; and by the Scott ·53 square inch. The depth of groove is ·125 inch, instead of ·18 to ·22 inch in the service guns. As the chief work is done on the driving side of the groove, and not on the loading one, by dispensing with depth on the latter side, the gun is still less weakened, from two-thirds to three-fourths less metal being removed than with the service grooving.

The relative weakening effect on the gun by the several systems of grooving may, in one point of view, be estimated by a consideration of the amount of metal removed per foot of bore in the formation of the grooves. It will be seen that in the 9-inch gun, Scott removes less than one-third the quantity of metal removed by the "Woolwich" system. This difference increases in favour of Scott as the calibre increases.

System.	Calibre.	No. of grooves.	Width of groove.	Depth of groove.	Metal removed for grooving per foot of bore.
	inch.		inch.	inch.	lbs.
Whitworth	8·25 9·05	6	3·3	·4	16·9
Lancaster..............	8·705 9·361	2	8·705	·328	15·66
Woolwich...............	9	5	1·5	·18	4·9
Scott....................	9	5	·8	·125	1·39

2nd. By shallowing the loading side of the groove the flanges rest on inclined planes, so that the projectile, when forced into its seat, has a natural tendency to slip round so as to cling to or bite the driving side before the gun is fired, to start easily, and to mount into the centering position the moment it begins to move out.

3rd. The axis of the bore and of the shot coincide in small arms and in expanding bullets, as the whole cylindrical portion bears. But, with iron shot, a space occurs above the shot when in its seat, through which the explosive gases try to escape, eroding or excoriating the upper part of the bore, forcing down the base of the shot and acting unequally upon it. Scott introduced the system of giving less windage to the rifling projections on the shot, than to its body, so that the shot rests upon its projections and its body does not touch the bore at all. His rib or flange running along the whole cylindrical part of the shot and carried up to the base, almost fills up the groove at the base, and checks the escape of the gas with its consequent erosion of the bore and unequal action on the shot; whilst by striking the curve of the cross-section of the groove and of the rib with two different radii, the latter is driven up into the centre of the bore at once, causing the axis of the shot and of the bore to coincide as with a leaden bullet. The centrical rib thus secures the even motion of the projectile along the bore, as pointed out by Holley in his work on "Ordnance and Armour," and in former lectures in this Institution. Major Palliser, in his "Treatise on Compound Ordnance," states that "the principle of centering the "shot in the gun was originally pointed out by Commander Scott, "R.N."

4th. The centering rib whilst thus nearly filling up the groove at the base of the shot, lessens the escape of gas over the shot, diminishes the downward blow on its seat, and diffuses the effect of the blow by receiving it upon a long rib instead of upon two studs $1\frac{1}{2}$ inches wide and $4\frac{1}{2}$ to 8 inches apart, the rear one of which is from $5\frac{2}{10}$ to $9\frac{1}{2}$ inches from the base. Erosion above and hammering below, are thus reduced.

Speaking of the present "Woolwich" system of rifling, Colonel Campbell, Royal Artillery, Superintendent of the Royal Gun Factories, states, 6th March, 1871, "that the scoring in the bores of heavy muzzle-" loading guns, due to the rush of gas over the projectile, is becoming " a matter for serious consideration, not so much as regards safety, but " as a point of economy, since the scoring arising from the use of " heavy charges wears out the tube locally, and involves the costly " operation of re-tubing the gun." This erosion is facilitated by wide deep grooves, and by the spaces in them between the studs.

5th. As to the projectile: the Ordnance Select Committee reported, 1863, that the centering iron-ribbed "projectiles have the merit of being " of convenient exterior form, easy to pile, but little liable to injury and " simple in manufacture;" and that this "form is the most advan-" tageous for a shell in respect to capacity." . . . "The Committee give " precedence, in respect to the efficiency of the projectile, to Commander " Scott," over seven other systems then tried, which included the present "Woolwich" or "French," the Armstrong "shunt," and the Lancaster. In 1865, the Committee reported that Scott's iron-ribbed shot cost £92 per thousand, and his shell £77 per thousand *less* than the "French" or "Woolwich" ones; whilst ten of his guns could be rifled in the same time as eight of the Woolwich ones at one-fifth less cost.

6th. The iron ribs which extend along the whole length of the cylindrical portion of the shell are cast with it, and impart strength to the walls. Moreover they diffuse the effort of rotation along its whole body and over the maximum length of the groove in the gun at a given instant: thus in the 7-inch double shell of $159\frac{1}{2}$ lbs. weight, the iron bearing would diffuse the strain over $3 \times 20{\cdot}5 = 61{\cdot}5$ inches, instead of concentrating the effort of rotation upon $3 \times {\cdot}6 = 1{\cdot}8$ inches, as at present. This shell is now balanced upon two studs equidistant from the centre of gravity, and 4·6 inches apart, the rear one, which does the work of rotation, being 9·55 inches from the base. Is it any wonder that it fails to rotate and topples over, and that the official work on "*Ammunition*," says "it is not contemplated to fire it at " long ranges, as its flight would be inaccurate, owing to its great " length;" whilst the Ordnance Select Committee report, "these shell " roll considerably owing to their great length and low velocity;" though great length does not prevent the long iron-bearing Whitworth shell receiving the necessary spin, even when five or six diameters long.

The principle of diffusing the effort of rotation over a large surface instead of concentrating it upon a small bearing is equally applicable to all calibres and projectiles, and is advantageous both to the steel lining of the gun and to the walls of the projectile, as is shown by the following Table; which shows an unsuccessful attempt to rotate a 530-lb. shell on $5\frac{1}{2}$ inches of stud-bearing, instead of employing the $15\frac{1}{2}$ feet of iron-bearing which is available upon the centering rib-system.

Common Shell.	Total length to be rotated.	Weight to be rotated.	Short stud-bearing.			Long rib-bearing.		
			No. of grooves.	Tangent of stud.	Total bearing.	No. of grooves.	Length of body of shell.	Total bearing.
	in.	lbs.		in.	in.		in.	in.
11·6-in. } 35 ton gun ..	29	534	9	·6	5·4	7	20·16	141·12
12-in.	34·45	700	9	·6	5·4	7	22·25	155·75
13-in. .. .. } 25 ton gun	29·3	600	10	·6	6	7	16·3	114·1
12-in., original,..	36·15	600	9	·6	5·4	7	23·85	166·95
12-in., reduced,..	30	495	9	·6	5·4	7	17·8	124·6
11-in., original,..	37·6	530	9	·6	5·4	7	26·525	185·675
11-in., reduced,..	27·5	402	9	·6	5·4	7	16·425	114·975
10-in., reduced, 18 ton gun..	32·5	400	7	·6	4·2	5	22·56	112·8
9-in., 12½ ton gun	26¾	250	6	·6	3·6	5	17·75	88·75
8-in., 9 ton gun	24·17	180	4	·6	2·4	3	16·27	48·81
7-in., 6½ ton gun	20·4	115	3	·6	1·8	3	13·7	41·1
7-in. *double*, 6½ ton gun	27·2	159½	3	·6	1·8	3	20·5	61·5

The French or "Woolwich" System.—(Plate XII.) The present service rifling is what was originally called the "French;" but ultimately, the grooves having been reduced in depth, the "Woolwich" system. It consists of deep, broad grooves cut with an increasing twist, each of which receives two soft-metal circular studs attached to the projectile. The original form of button and groove was presented to the French Government by Colonel Treuille de Beaulieu, in 1842, and, in a modified form, it was adopted in our service in 1865, after the 7-inch gun competition. That competition had not proved the superiority of the French to other systems, but sufficient worth was discovered in it to afford some hope that, under Major Palliser's able and ingenious manipulation of the studs, it might suffice for general purposes. Seven years energetic and intelligent labour have been bestowed upon the system by the manufacturing departments at Woolwich, whose chiefs are second to none in capacity and zeal. Seven years have all the resources, intellectual and material, of a government establishment been freely devoted to improving the "French" stud system; and we may now confidently affirm that if it has failed in any particular, this cause of failure must be looked for, not in the manipulation of details, but in the principles involved.

The reasons assigned by the Ordnance Select Committee in 1865, for preferring the French or "Woolwich" system are thus stated in their Report: "*The shooting qualities of these guns are so nearly alike*, that "the Committee feel they may rest their recommendation of the one or "the other system upon other and more general considerations, and "they have finally determined to record their unanimous opinion in "favour of the so-called French system, 1st, because of the simplicity

" of its studding on the projectiles; 2nd, the simplicity of the grooving " of the gun; and 3rd, from a disposition to admit of the advantage " of an increasing over a uniform spiral, which has been strengthened " by the present trial. This advantage can best be realized with *a* " *short bearing* on two points."

The Increasing Spiral. (Plate XIII.)—The increasing spiral has, notwithstanding this Report, been abandoned for this nature of gun, the 7-inch, and has not been used with any lighter guns, and only obtains in its entirety in four natures of guns, the increase being from nothing, *i.e.*, from a straight groove at the seat of the shot to one turn in 40 calibres at the muzzle in the 8-inch 9-ton gun; to one turn in 45 calibres at the muzzle in the 9-inch 12½-ton gun; to one turn in 35 calibres at the muzzle in the 11-inch 25-ton gun, and in the 12-inch 35-ton gun. But a compromise of twists obtains in the 10-inch 18-ton gun, the spiral of which begins at one turn in 100 calibres at the seat of the shot, and increases to one turn in 40 calibres at the muzzle; and in the 12-inch 25-ton gun, to one turn in 50 calibres at the muzzle. The latest idea evidently is to begin with a straight groove, and gradually to reach a spiral of one turn in 35 calibres at the muzzle, though I have been unable to find a single experimental fact to justify it, and it has produced the worst results.

The angle of spiral required to impart adequate rotation to projectiles of different lengths has been experimentally determined by Sir Joseph Whitworth, for guns with long iron bearings. But the number of calibres in which one turn of rifling is to be effected on the present service system, is limited by the incapability of six-tenths of an inch of bearing to sustain the effort of rotation, if the effort be increased by the use of more rapid angles. The practical formula adopted is, therefore, that popularly known as the " rule of thumb." By applying this formula to the varying degrees of spiral which exist in the " French," or " Woolwich " grooved guns, it will be found to coincide with each and all.

The professed object of the increasing spiral is to enable the shot to slip away easily from its seat, and give room for the powder gases to expand, and then to grip the projections of the shot whilst in full flight when it is near the muzzle and give it the necessary spin after the powder-chamber has been relieved of its initial pressure. On the other hand, a uniform spiral grips the shot in a state of rest, and impresses on its first and slowest motions the rotation with which it is intended that it should leave the gun. The question is, which brings least strain on the gun, the effort to grip the shot after it has attained great velocity, and to turn it out of its headlong flight with a view to giving it the requisite spin, or the effort of impressing this rotation upon it at once as it begins to move? The War Department answer by applying the uniform twist to all the guns of and under 7 tons weight, including the longitudinally weak converted or half cast-iron guns; and the increasing twist only to the strong wrought-iron coil guns which are supposed to be capable of standing anything. The American General Gillmore attributes the blowing off of their muzzles by the 23 hybrid Parrott guns at the siege of Charleston to the increasing twist.

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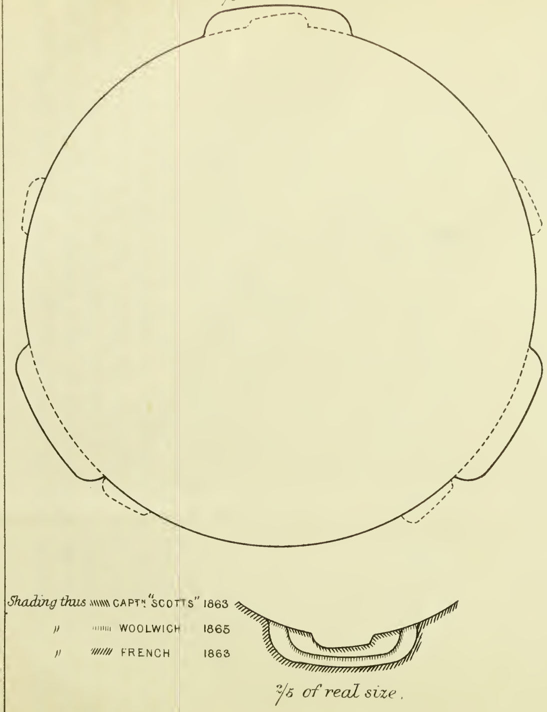
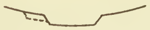
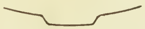
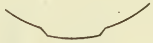
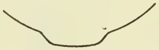
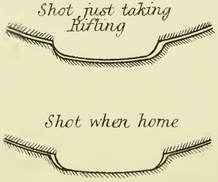
7 INCH COMPETITIVE GUN
French and Scott
2/5 of real size.

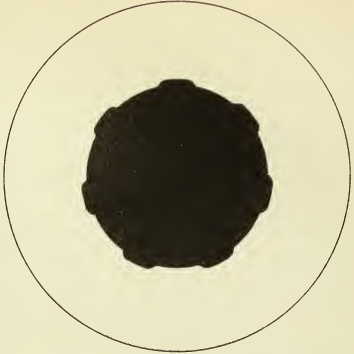


SYSTEM OF RIFLING	FORM OF GROOVE 2/5 of real size.	No. of Grooves
ARMSTRONG *as applied to the* 64 PR. GUNS 1863		3
MODIFIED ARMSTRONG *as applied to the* 64 PR. PALLISER GUNS. 1867.		3
FRENCH (ANGLED) *as applied to the* 7 PR. GUNS 1865.		3
MODIFIED FRENCH *as applied to the* 9 PR. BRONZE GUNS *Colᴸ. Maxwell* 1869		3

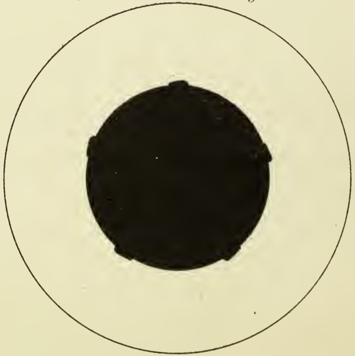
WOOLWICH RIFLING



10 INCH M.L. GUN 18 TONS
"Woolwich" Rifling.



Captain "Scotts" Rifling.



J. Jobbins.

The early Lancaster guns lost their muzzles from the same cause; and none have so failed since the increasing spiral was abandoned. Colonel Owen's "*Modern Artillery*" tells us that an experiment with increasing and uniform twists showed considerable difference in initial velocity. Five rounds were fired with each twist from the 8-inch gun, the shot (hollow) weighing 179 lbs., and the charge being 30 lbs. The mean initial velocity, and the corresponding blow at the muzzle, given by—

	Velocity.		Total energy.
The uniform twist was	1,338·6 feet	=	2,237 foot tons
The increasing twist	1,303·3 feet	=	2,121 foot tons
Penetrating power lost by increasing twist	35·3 feet	=	116 foot tons

The Admiralty of 1865 were dissatisfied with the absence of all foundation for the favour shown to the increasing spiral, and "at the request "of his Grace the Duke of Somerset, who desired to test the relative "qualities of increasing and uniform twists," two 7-inch 6½-ton guns were prepared and tried with "Woolwich" rifling, but with the two kinds of twist, each ending in one turn in 37 calibres. The initial velocities and the corresponding blows for shot of 115½ lbs., with 22 lbs. R.L.G. charge, were:—

	Velocities.		Total energy.
Uniform twist............	1,465·0 feet	=	1,712 foot-tons.
Increasing twist..........	1,443·8 feet	=	1,656 ,, ,,
Penetrating power lost by increasing twist.......	21.2 feet	=	56 foot-tons.

"The blow struck by the one shot on leaving the muzzle, would be "to that struck by the other, as 100 to 103." Using 12- and 14-lb. charges, "with hollow shot the uniform spiral continues to yield a "slight superiority in accuracy over that of the increasing spiral." The Committee, however, had some speculative theories about the greater initial velocity being due to increased pressure in the powder chamber, and uphold their former guess in favour of the increasing spiral. But Colonel Younghusband, R.A., no mean authority, "records his dissent from the opinion of the majority of the Com"mittee, and does not consider the adoption of an increasing spiral as "warranted by the present comparison." The Admiralty agree with that officer, though they have all these official reports and tables of practice before them, and order that their then great broadside gun, the 7-inch, shall have an uniform twist. More recently the Committee on Explosives have shown that, with R.L.G. powder, the maximum pressure in the chamber is relieved by the first *quarter of an inch* of onward movement, but there is not, and cannot be, a tittle of evidence to show that any difference of velocities obtains between the two forms of spiral in that quarter of an inch. In the case of pebble powder, the maximum pressure of which is about one-half that of R.L.G., this does not occur till the shot has moved six inches, by which time the uniform spin is fully impressed. Further, the Committee on Explosives report, 1st

January, 1871, on some experiments with a 10-inch gun in its smooth-bore and in its rifled state that, "The general results exhibit a slight diminution of velocity, and likewise a slight *diminution of pressure* consequent on rifling. These results are insufficient to form a basis for any general conclusion; they, however, appear to indicate that there is *no important difference in either velocity or pressure between the gun in its rifled and in its smooth-bore state.*"

If this be anything like the truth, then the guess made, in 1865, as to a uniform twist giving more pressure in the chamber than the increasing, is a proved absurdity, for neither give more powder pressure than a plain unrifled cylinder. The extra initial velocity of the uniform twist does then arise from the greater ease with which the shot escapes out of the muzzle. And the difference of endurance is to be looked for not in the powder chamber, but outside the area of maximum powder pressure, in the grooves and lands of the bore, and in the marks and strain on the projectile.

We have further evidence that difference of powder pressure within the possible limits due to the adoption of an increasing or of an uniform spiral, has little or no effect on the longevity of guns. Take two extreme cases, 1st, that of the 7-ton gun, bored up to 8 inches, and now in use to test powder pressures, &c. It has 21 holes, each an inch in diameter, made right through its walls, at different points from breach to muzzle. In this enfeebled state it has fired many hundred rounds of 35-lbs. charges with 180-lb. shot, though the gun was only built for 22-lbs. charges and 115-lb. shot in its perfect state. 2nd. That of the 10-inch 18-ton gun, now in use for a similar purpose, which has 18 similar holes, communicating from the exterior into the bore for the insertion of crusher gauges. In this weakened state it has fired many hundred powder charges, each of from 60 to 87½ lbs., with 400-lbs. shot, the strains resulting from some of the R.L.G. charges being over 60 tons on the square inch. Yet this gun is as strong as ever. Hence it is evident that pressure in the powder chamber, within ordinary limits, is not the usual cause of the maladies to which the present service guns are heir.

Effort of Rotation.—The greater relative strain on the gun caused by the French rifling over that caused by the Scott rifling, was remarked in 1863 in the report of the rifled cast-iron gun competition. Taking as a comparative measure, the average pressure, as far as the trunnions, multiplied into the resistance or weight moved per square inch of section, the relative strains were in the ratio of 923 tons to 720 tons, and accordingly the French cast-iron rifle-gun burst at the 107th round, whilst the Scott did not do so till the 310th*. This evidence is not, perhaps, so conclusive as to the spiral as the 8-inch gun experiment referred to by Colonel Owen, for the short-bearing stud may account for much that was bad in the French or Woolwich gun, as compared with the long-bearing rib; but that the increasing spiral had something to do with it may be inferred from the fact that the relative strain on the studded Shunt cast-iron gun with a uniform twist is recorded as 798 tons, though it did not burst till the 327th round.

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* This was the second gun thus rifled. The first cast-iron 32-pr. gun rifled for long iron bearings for this competition, was cheaply and imperfectly grooved at the inventor's own cost; and, as can be seen in this Institution, the experimental shot were ill-shaped at the base for endurance, and the iron ribs of a bad form, quite different from those subsequently adopted. These imperfect projectiles were 41 lbs. weight, and were fired with excessive powder charges of 7 and 7½ lbs., which burst the gun at the 79th round.—W.D.

As to strains incidental to the form of groove, independent of the nature of the twist, Mr. J. Anderson, the talented Superintendent of Machinery at the Royal Arsenal, some years ago tested experimentally the strain to the gun resulting from the effort to rotate projectiles by different systems of uniform rifling. Several cast-iron cylinders, of equal strength and area were bored and rifled on each of the various plans. Into these rifled cylinders corresponding plugs of steel representing the projectile were correctly fitted; the other end of the steel plugs being fixed into immoveable frames. The cylinder was fixed in the centre of a lever fulcrum, capable of having a torsional motion given to it by the application of weights on the extremity of the lever. The greater the weight required to fracture the cylinder, the more the endurance due to the given system of rifling; and by dividing the breaking weight by the number of grooves or bearings, we get the endurance of each bearing. The result, given at p. 583 of the Report of the Select Committee on Ordnance, 1863, shows that the Lancaster oval plug split the cylinder representing the gun when each of the two bearings sustained 3·51 tons; the Whitworth split when each of the six bearings sustained 4·68 tons; Armstrong's "Shunt" stud (which is the nearest approach to the "Woolwich" stud tried) split when each of its three grooves sustained 8·55 tons; whilst Scott's did not split until each of the three grooves sustained 11·77 tons.

	Breaking weight at circumference.	Breaking strain each bearing.
	Tons.	Tons.
Lancaster's oval	7·02	3·51
Whitworth's hexagon	28·07	4·68
Armstrong's three groove shunt	25·65	8·55
Scott's three grooves	35·30	11·77

The Heavy Gun Competition.—As there has been only one heavy gun competition (the 7-inch, of 1865) in this country, I am compelled to refer to the facts then obtained in judging of the comparative value of the only systems for such weapons of which we have official comparative experience.

The Report on the 7-inch gun competition tells us that "the gun "rifled on the French (Woolwich) system has* decidedly the lowest

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* See "Extracts from Reports, &c., of Ordnance Select Committee," vol. ii, p. 292, sec. 13. In the version of the Report presented six months afterwards to Parliament, this statement is qualified by interpolating at page 4 the unmeaning expression "*somewhat* decidedly the lowest velocities," which hardly does justice to 133 foot tons lighter muzzle blow than the centering ribbed-shot.

"velocities." When firing a 110-lb. shot, "in order that the very "best shooting qualities of the guns might be developed," Scott's gun with uniform twist, gave with a 25-lb. charge, 59 feet greater initial velocity than the French gun with increasing twist and studs; with a 20-lb. charge, Scott's uniform twist gave 52 feet more initial velocity, and with 12-lb. charge it gave 18 feet more, striking blows 133, 121, and 27 foot-tons heavier with the same weight of shot; or 264 foot-tons more than the battering charge of the present service 7-inch guns. These figures represent the extra difficulty experienced by the slower shot in escaping from the gun, and, therefore, the extra strain thrown on the gun in unnecessarily retarding the shot, and gripping it when at full flight instead of when at rest. Accordingly we find this extra strain telling on the gun and recorded in the same report. After the "French" gun had fired 567 rounds, and the Scott gun 417 rounds, they were both examined by the Inspector of Ordnance, who reports certain minor damages common to both, and a more serious cavity in the axis at the bottom of the bore, due to the conical form of their chambers, and then enumerates the following extra punishment inflicted upon the "French" gun by its own studded shot and increasing twist:—"The "A tube is cracked longitudinally in the leading corner of the up-"groove, from 11½ to 19½ inches from the bottom of the bore.

"The dents in lands and grooves, from 20½ to 21½ inches from "bottom of bore, appear to have slightly increased in depth;" whilst Admiral Dunlop inspected the Scott gun, in which the grooves were as accurate as when they left the machine, the original gauge completely filling the bore.

"The bore" of the "French" gun was "also slightly enlarged;" the maximum enlargement being ·049 inch at 21 inches from the bottom, whilst the Scott gun's was only ·002 inch.

"This gun," proceeds the Report, "should, in future, be fired '*under precaution*,'" *i.e.*, in anticipation of a burst.

The last heard officially of these two competitive guns is in a Parliamentary return, April, 1866, when, besides the defect in the axis of the piece due to the conical form of chamber, it is remarked that the "French" gun is "cracked in the tube," and that the Scott gun is "since bored up to 8·03 inch." The same return tells us of another 7-inch gun of 5 tons, of which "the inner tube was split, and the "gun received a new one" at the 800th round; and the practice being continued with the new tube, at the 50th round "there is a slight "indication of a crack in the corner of one of the grooves on the "driving side, nearly at the end, and a wearing of the edge of the "grooves commencing 7½ inches from the end." Was this the reason why the increasing twist was abandoned for all guns of 7 inches and under?

Turning from the effect of an increasing twist, a deep wide groove, and short bearing upon the gun, to that upon the range, we find, by the only "heavy" gun competition, (with 7-inch calibres in 1865), that it takes 25 lbs. of powder to send the same weight of shot the same distance as it is sent when provided with the long iron-bearing flanges and uniform twist when fired with a 20-lb. charge at the elevation due to what the late Director-General of Naval Ordnance esteems the practical fighting distance at sea, viz., 1,473 yards. This saving of one-fifth of the powder charge must have a most beneficial effect on the erosion of the bore, and consequently on the life of the gun. As the same range is attained by the centering ribbed shot with a less initial velocity, it is evident that the French shot lost range by eccentric and noisy gyrations in the air, due to its wabbling and hammering motion in the gun.

Solid 110-lb. projectile.	Powder charge.	Initial velocity.	Total energy at muzzle.	No. of rounds.	Elevation.	Mean of all ranges.	Mean diff. of range.	Mean reduced deflection.
	lbs.	feet.	foot-tons.		°	yards.	yards.	yards.
Scott's iron-ribbed	25	1,583	1,908	15	2	1,585	17·7	1·1
French zinc stud	,,	1,526	1,775	,,	,,	1,473	62·2	1·9
Scott's iron-ribbed	20	1,493	1,701	15	2	1,473	18·1	1·3
French zinc stud	,,	1,441	1,580	13	,,	1,379	37·1	0·9
Scott's iron-ribbed	12	1,270	1,222	5	2	1,213	21·4	0·8
French zinc stud	,,	1,252	1,195	4	,,	1,152	19·7	0·8

Higher elevations are, for naval purposes, of little consequence, but it is interesting to note that the 110-lb. centering iron-ribbed shot gave at 5°, with 25-lb. charge, as a mean of fifteen rounds, 2,914 yards range, being 163 yards more than the short-bearing studs, and with slightly better accuracy, though an arithmetical error in the report makes it the reverse; and at 10°, which is of still less consequence, the iron-ribbed shot gave, with 25-lb. charge, as a mean of fifteen rounds, 4,798 yards, or 259 yards more than the short-bearing studs, the accuracy being again in favour of the long-bearing ribs. With 20-lb. and 12-lb. charge a similar superiority of range and accuracy was recorded for the long-bearing 110-lb. shot, save that with the latter charge a greater mean lateral deviation from the mean line of fire at 3,909 yards, proved that the angle of twist then adopted by Scott (one turn in forty-two calibres) was less effective in securing rotation than that selected for the French gun—one turn in 37 calibres.

Subsequently "the arrangement of the studs was altogether altered, "on a plan suggested by Major Palliser, the metal was changed from "zinc to gun metal, the smaller stud was placed in front and the larger "behind; both were attached in a different manner," and the weight of both shot was reduced to 100 lbs.; Captain Scott being unhappily induced to try the effect of a soft zinc lining for the iron flanges. The result was that the shooting of the centering-iron shot was spoilt by the soft bearing, whilst the shooting of the French gun was improved by the hard bearing. Still we find that, correcting the arithmetical errors of "Table II. Practice for Range and Accuracy," and taking the mean of the ranges given with 12-lb., 20-lb., and 25-lb.

charges at Admiral Key's fighting ranges, the spoilt centering-ribbed shot obtained 53 yards more range at 1,377 yards, and 30 yards more at 2,543 yards than the French improved by Palliser's stud. The initial velocities and consequent blows at the muzzle were also greater with the spoilt centering rib, using 25- or 12-lb. charges, though, strange to say, it was somewhat less with a 20-lb. charge than the French, but sent its shot, even then, 97 yards farther at 5°, and 32 yards farther at 2° elevation.

Solid 100-lb. projectile.	No. of rounds.	Elevation.	Mean range.	Mean deviation of range.	Mean reduced deflection.
			yards.	yards.	yards.
Scott's zinc ribbed	31	2°	1,377	45·8	2·1
French, with gun-metal studs	"	"	1,324	20·2	2·8
Scott's zinc ribbed	30	5	2,543	50·8	3·2
French, with gun-metal studs	25	"	2,513	35·1	2·3

The ranges at 10°, being beyond useful fighting distance, are of no practical value; but it is interesting to note that the spoilt soft zinc-ribbed 100-lb shot gave, taking the means with all three charges, 4,133 yards, or 249 yards less than similar mean ranges with all three charges, using the iron bearing 110-lb. shot, and 142 yards less than the Palliser hard studded French 100-lb. shot.

As round shot have special advantages in ricochet for sea service, this point was tried with 12-lb. and 20-lb. charges, the means of 65 rounds, giving a range of 86 yards in favour of the shallower and narrower grooving for the centering rib:—

43½-lb. round shot.	Mean range.	Mean difference of range.	Mean reduced deflection.
	yards.	yards.	yards.
Scott's gun	1,818	81·6	11·5
French gun	1,732	55·9	6·7

The initial velocities taken with round shot, and the corresponding blows at the muzzle, show a loss of 117 foot-tons in the blow given by the French gun. They were:—

43½-lb. round shot.	20-lb. charge.		12-lb. charge.	
	Initial velocity.	Total energy.	Initial velocity.	Total energy.
	feet.	foot-tons.	feet.	foot-tons.
Scott's gun	2,162	1,410	1,827	1,008
French gun	2,081	1,307	1,718	891
Lost by wide deep grooves....	81	103	109	117

The report of the cast-iron gun competition, with rifled 32-pounders in 1860–3, shows that at 2° elevation, the French or "Woolwich" rifling gave 270 yards less range than Scott's gun, and at 5° elevation, 267 yards less range. The French cast-iron gun was also less accurate with both elevations, though the increasing spiral ended with an angle of 2° 53′ at the muzzle, Scott's uniform spiral being in the corresponding cast-iron gun only 2° throughout; but the approximate area of bearing surface is given in the Report, as 19·5 square inches with the Scott shot as against only 4·7 square inches in the French one, and the area of the guiding edges is stated to be 3·9 square inches in the Scott, as against ·6 in the French. Doubtless it was the uniform spiral and additional bearing which made amends for the smaller angle of twist, rotating Scott's shot more perfectly, and giving it superior accuracy and range in the cast iron, as in the heavy gun competition.

Rifled cast-iron 32-prs., 1860–3.	No. of rounds.	Elevation.	Mean range.	Mean difference of range.	Mean reduced Deflection.	Rectangle containing half the shots.		Relative weight of bursting charge of shell.
						Length.	Width.	
		°	yards.	yards.	yards.	yards.	yards.	
Scott's....................	9	2	1,129	19·7	2·4	58·5	7·1	·124
French....................	30	„	859	20·4	1·78	60·3	4·5	·090
Scott's....................	30	5	1,975	37·5	2·8	108·7	8·2	·124
French....................	11	„	1,708	41·8	3·51	125·1	9·6	·090

Returning to the heavy gun competition we find that the mean of the only 60 rounds of common shell, with hemispherical heads, weighing, when filled and plugged, 100 lbs., fired with 20-lb. charges, at 2½°, 5⅛°, 10½°, after correcting arithmetical errors in the Report, gave the iron rib 36 yards preference.

100-lb. shell and 20-lb. charges.	No. of rounds.	Corrected elevation.		Mean range.	Mean difference of range.	Mean observed deflection.	Mean reduced deflection.
		°	′	yards.	yards.	yards.	yards.
Scott's iron-ribbed	1	2	14	1,414	—	1·2	—
" "	19	2	15	1,380	14·1	3.8	1·0
" "	20	5	8	2,557	36·4	17·1	1·8
" "	20	10	5	4,149	35·5	79·7	6·7
Mean of all ranges	..	..		2,375	28·7	25·4	3·2
French, gun-metal studs	1	2	14	1,412	—	7·7	—
" " "	19	2	15	1,335	21·3	4·0	0·8
" " "	20	5	8	2,490	33·8	19·0	1·4
" " "	20	10	5	4,119	41·7	93·9	6·1
Mean of all ranges	..	..		2,339	32·3	31·1	2·8

Endurance of Guns.—The advantage in range, with all these various projectiles, and the additional force of blow at the muzzle, is chiefly noteworthy because the conditions being alike in all respects, except the length of bearing and twist, it shews, from another point of view, that the slower shot which attained the smaller range had greater difficulty in escaping from the bore, and that the extra effort of rotation with the increasing twist and short-bearing threw so much more strain upon the gun.

This extra strain is evidenced by the projectiles occasionally dragging their studs across the lands, or breaking up in the bore, and wearing out the steel linings of the guns, by abrasions and cracks in the grooves, or by the erosion of the escaping gases; so that the 10-inch 18-ton gun is officially regarded as only capable of firing 500 rounds, of which half to be battering charges, and the 11-in 25-ton gun, 250 rounds, of which 100 may be battering charges, before careful professional examination. No rule has yet been laid down as to the limit of the discharges of the 35-ton gun; but as the lining cracked at the 68th round, its endurance is probably much less than that of the 25-ton gun. What would be the life of these heavier guns, if subjected to rapid firing in a naval engagement, has not been tried.

Endurance of Studded Projectiles. (Plate XII.)—Though the programme of the 7-inch gun competition stated that its object was to ascertain "which of these five systems of projectiles and four systems "of rifling is to be preferred," little attention was bestowed upon the question of endurance as affecting the hollow projectile. But eighteen months afterwards, on the 13th December, 1866, Colonel J. H. Francklyn, Commanding Royal Artillery, Halifax, Nova Scotia, reports:—"In the "last lot of 9-inch shot (by the barque 'W. G. Putman') there are a

" considerable number that appear to me quite unfit for issue in their " present state, as some of the *studs are shapeless blotches of gun-metal*, " scarcely projecting at all from the surface of the shot, and evidently " quite unfit to get a grip on the grooves of the gun, if fired; this " appears to be either that the studs have been bruised down, and " worn away by the shot grinding together, probably on board ship, or " else that the shot have, by some oversight, been issued in an unfinished state;" on this, it was "recommended that steel shell should " be issued for transport in boxes, or in coarse gunny bags;" . . . and that there be "an early shipment to Halifax of 200 9-inch Palliser " shell, 100 in gunny bags, 100 with two grummet rings snaked " together, the rings to be outside the studs." By these means, and the occasional use of a file before loading, this difficulty appears to have been overcome. Contrast this with the official report that the iron rib "projec- " tiles have the merit of being of convenient exterior form, easy to pile, " but little liable to injury, and simple in manufacture." The liability to self-destruction on firing is shown by a general order now in operation, that studded " Palliser projectiles which have been fired and recovered, " are not to be used again, as it has been found that they are liable to " break up in the bore when fired a second time," and injure the gun. On the other hand, in the report of the rifle cast-iron gun competition, the Superintendent at Shoeburyness remarks in the practice return, 5th March, 1861, of the centering ribbed projectiles, "the old shells have " been fired, on an average, *about six times each;* none have cracked;" showing that casting long flanges on the projectile imparts strength, and that diffusing the effort of rotation along its whole cylindrical body, saves the life of the shell. And in the 7-inch gun competition, 1865, of 40 studded shell recovered, 28, or 70 per cent., had some of the rear studs displaced or, in two cases, wrenched out, and none were re-fired. In other cases, "it was noticed at each round, from the third to the " sixth inclusive, that a stud appeared to detach itself from the French " shot during flight;" and " in rounds 306 to 309 inclusive, it appeared " as though a stud fell off during flight."

Five of Scott's recovered 7-inch shell were loaded with powder and re-fired without bursting, confirming the previous experience in 1861, when they were re-fired six times over.

In studding a projectile, a ring of circular holes, each ·3 inch deep and 1·6 inch diameter is cast in the walls from 2·3 inches to 4 inches behind the centre of gravity for the rear studs, the heads of which are 1·45 inches in diameter, and ·195 inch above the surface. Another ring of circular holes of the same depth, but each one-tenth of an inch smaller in diameter, is cast in the walls the same distance before the centre of gravity, for the front studs, the heads of which are 1·2 inches in diameter and project ·195 inch above the surface. The number of holes in each ring correspond to the number of grooves in the gun. Thus, a 9-inch common shell has two rings of six holes each, in its weakest part, reducing its walls, which are 1½ inch thick to 1·2 of an inch over a sectional surface of 9·6 inches in case of the rear ring, and 8·1 inches in the case of the front ring, or for about one-third the circumference. The material of the studs has been the subject of much experiment;

and they now consist of an alloy of 7 copper and 1 tin, except for shrapnel and for 7-inch shells, when the proportions are 10 of copper to 1 of tin. They are swedged cold into the holes in the projectile, which are undercut to receive them, an operation which must further weaken the walls.

Major Palliser explains in his "*Treatise on Compound Ordnance*," that the rear ring of studs being made larger than the front ones, the rear ones at starting do all the work of turning in the slot. As the shot, however, travels up the bore, he says the friction will wear down the rear studs, and the assistance of those in front will thereby be gradually called in. This assistance is, however, so small that it was recently desired to strengthen the shell by doing away with the front ring, which are called mere "guiding" studs, the rear ring being called the "driving" ones. The wearing away of the "driving" studs pointed out by Major Palliser obviously defeats the intention of centering the projectile, or causing its axis to coincide with that of the bore, which he so highly values. The official work on "Ammunition," Part II, page 58, states that the intention of centering the projectile is not realised with studs in consequence of the softness of the gun-metal; and that "the Committee on Field Ord-"nance for India report that recovered projectiles fired from an "experimental 'Woolwich' gun showed clear evidence of non-"centering." The groove for the Indian field guns was made, therefore, with its loading side sloped, and has an uniform twist; and, page 93, "it was found by the Committee that better results were "obtained with this system, which was advocated by Colonel Maxwell, "than with the 'Woolwich,' the projectiles, having a rather greater "initial velocity, and giving better shooting." Nevertheless, the ill effects of the short bearing remained, preventing the use of the original long double 7-pounder shell, and necessitating (page 96) its reduction in length, in bursting charge, and in power. Colonel Owen writes:—"In hard projectiles having studs there will generally be a slightly "oblique movement of the axis of the projectile;" in other words "wabbling" occurs in the bore, the studs are sheared or wrenched out of their sockets; a puffing "noise" is heard in the flight, and if the shell do not break up, they reach their destination broadside on.

That the weakening of the walls by so many holes, and the concentration of the effort of rotation on the rear holes does seriously affect the endurance of the projectile we have much official evidence. The official volume on "Ammunition," Part II, published 1870, after upwards of five years' experience of the "Woolwich" rifling, says, at page 73, "The "effect produced by the pressure on the sides of a M. L. common shell "from the gas rushing past is found to be most remarkable, the shell "having a tendency to assume a form approaching that of a dumb-bell. ". . . The body about the middle, where it is weakest, is forced "inwards and decreased in diameter to an extent which would hardly "be credited. For example, the diameter of a 9-inch shell has been "reduced from 8·92 inches to 8·55" (or ·37 of an inch) "about the "middle." Again (page 91) of "Ammunition," Part II, "A cracked "(Palliser) projectile may be surprisingly easily divided into two by

" a blow on the stud fixed on the present system. If shot are found " split in store, the crack generally runs through stud holes," and the same effect is observed when they break up in the gun or on striking a hard object.

12-*inch* 25-*ton Gun, Common Shell.*—Turning to the quarterly *Extracts from the Proceedings of the Department of the Director-General of Ordnance selected by order of the Secretary of State for War*, and passing over the first three years after the adoption of the "Woolwich" system, we find it reported, in February, 1868, of the 12 common shell 600 lbs. weight, 36·15 inch long, containing 45½ lbs. bursting charge, that "the " practice with the common shells was stopped on account of the " shells appearing to turn over in flight. All had two studs in each " groove, eighteen in all; but they were . . . . only six " inches apart." In March, 1868, of ten rounds fired with 55lbs. charge "two surged in flight; eight very unsteady." Of ten rounds fired with 60 lbs. charge, "all very unsteady." "A shell struck the " muzzle in loading and dropped on ground out of the lifter. In ramming home afterwards, shell jammed, probably owing to studs being " burred by the fall." Another "shell jammed three inches off end of " bore, and could not be forced home." Of ten rounds fired, in April, 1868, with 40-lb. charges, "two tolerably steady, three unsteady at " first but steadied; one unsteady, and four very so." "An additional " rear ring of studs of reduced gauge" suggested, but the "committee " prefer to try the effect of reducing the weight of the projectile." Accordingly, the studs being incapable of giving sufficient rotation to the 12-inch common shell, "these proved on trial so exceedingly " unsteady in flight and shot so indifferently" that they were reduced from 600 lbs. weight to 495 lbs. weight, and their bursting charge from 45½ lbs. to 35 lbs. We thus sacrifice 105 lbs. weight in the 12-inch common shell and 10½ lbs. of bursting charge, because a short bearing cannot give rotation to a long shell. Nor is this all. The capacity of the original 600-lbs. 12-inch common shell was determined by the necessity of having walls 1·96 inches thick, to allow for two rings of nine circular holes, each ·3 inch deep and 1·65 inch in diameter, and for the concentration of the whole effort of rotation on the rear weakening ring. Had that shell been strengthened by seven cast-iron ribs instead of weakened by two rings of eighteen holes, the capacity of the 600-lbs. shell might have been increased to receive a 60-lb. bursting charge, instead of our now being obliged to use a 495-lbs. shell with a 35-lbs. bursting charge.

The official work on "Ammunition" says:—"The weights of all the " projectiles of each calibre (except case shot and double shell) approximate as nearly as possible, . . . with the 12-inch gun, there is " a serious departure from this system in the case of common and Shrapnell shell," owing "to the unfortunate introduction of the 12-inch " gun *with such a twist* as rendered it necessary to discard its two " longest projectiles, viz., its common and shrapnel shells, constructed " at first to weigh about 600 lbs., on the score of bad shooting, for two " shorter and much less powerful ones, weighing only about 495 and " 496 lbs. respectively."

The practice with the reduced 12-inch shell is reported (15th October, 1868,) to be "remarkable for its goodness," yet we read "ten shells "have been recovered. In several, the rear studs have been slightly "moved forward by the explosion of the charge, and all are scored on "base (for about $\frac{1}{5}$th of the circumference) by the grooving of the gun; "the length of the scoring averages about 3 inches." If the studs had worked truly, the body of the shell could not have touched the bore at all; the scoring of the base shows that the shell wabbled in, and hammered, the gun.

12-*inch* 25-*ton Gun.*—The bad shooting, and the erosion of the bore still continue after taking one-sixth from the weight and nearly one-fourth from the bursting charge of the shell, it being impossible to give even the reduced projectiles adequate rotation. We find that Colonel Campbell, Royal Artillery, the talented Superintendent of the Royal Gun Factories, submitted a memorandum to the Ordnance Council, on the then proposed 35-ton gun competition, 4th May, 1870, in which he says:—

"The 'Woolwich' system of rifling adopted in the service, required "metal studs on the projectiles, which are objectionable from their "liability to shear, and thus prevent the correct centering of the shot, "and their liability to become damaged in transport and on service. "In heavy guns, the liability to shear, necessitates an increased number "of grooves if a quicker twist than now employed, is given. The "system has the great disadvantage of local scoring. . . . . I mean "to say that there are disadvantages in the 'Woolwich' system in "that way, and a better system of rifling might be found."

Colonel Campbell was asked by the Director-General of Naval Ordnance;—"Do you consider that the increase of the twist given to "this (35-ton) gun will entirely obviate *the inaccuracy of flight now* "*observed in the* 12-*inch gun of* 25 *tons* at very short ranges?" and replied, "*No, I should not think it would altogether*, I think it will "improve it very much. I should like to have given a greater twist."

Again, "should you be afraid if you adopted a sharper twist, say 1 "in 25, that the studs would be sheared?" "I should be afraid so, or "I would have adopted it. The stud in the projectile confines us to "giving a less twist than I should like to give to any gun."

To which Sir Joseph Whitworth truly added "if you have projectiles "of a certain length, you must have a greater twist. . . . The "question is, is it desirable to be able to fire a shell six diameters long "holding a double charge of powder? If you say 'yes,' then you "must have a greater twist, because with less, the projectile turns "over."

The "Monarch's" four 25-ton guns having been examined after firing an average of only 35 charges each, 20 being battering charges, were reported, April, 1870, to have "a very slight burring up of the "driving sides of the grooves for a short distance from their origin. "This is just to be perceived in all the guns" (though two of them had only fired 9 battering charges each) "but is so slight as *at* "*present* to be quite unimportant." One of the guns had to be re-vented.

11-inch 25-ton Gun.—This and the 35-ton guns are the only ones in which, with an increasing spiral, so rapid a final twist as one turn in 35 calibres, obtains. Let us observe the result. It was computed that by reducing the 12-inch 25-ton gun to an 11-inch bore, it gave with the same 70-lbs. R.L.G. charge, but with a 70-lb. lighter shot, *i.e.*, a 530-lb. shot instead of 600 lbs., five foot tons per inch of shot's circumference, more penetrative power both at the muzzle and at 1,000 yards, though of course the total energy or hitting force was greater in the 12-inch. Thus, at 1,000 yards, the 70-lb. R.L.G. was computed to give—

	12-inch. 600-lbs. shot.	11-inch. 530-lbs. shot.
Velocity	1,108 ft.	1,149 ft.
Total energy	5,108 ft. tons.	4,852 ft. tons.
Energy per inch of shot's circumference ..	136·4 ft. tons.	141·4 ft. tons.

Powder-pressure experiments are not always reliable; but it was at one time stated, that the pressure on each square inch of the 11-inch powder chamber, using R.L.G. powder, was $\frac{12}{100}$ths greater than the 12-inch; but that the strength gained by the extra metal rendered the 11-inch gun more than $\frac{22}{100}$ths per square inch stronger than the 12-inch; the balance of endurance, and the penetrative power, lying therefore with the 11-inch bore. But the proper calibre is a question of compromises, and a 12-inch shell, with its extra weight, large hole, and large bursting charge, and the impossibility of giving rotation by studs, and increasing twist to the proper sized shell for either bore, have to be placed on the other side. At present the authorities have decided for the smaller bore.

With pebble powder the penetrating power of the smaller bore is, however, at 1,000 yards, only one foot-ton on each inch of the shot's circumference greater than the 12-inch. But after practice at the two turret targets at Shoeburyness, the Committee report, of the 25-ton guns that, "There is little practical difference in their perforating "powers when firing the same charges; the total work done, however, "by the 12-inch gun is greater than that done by the 11-inch." These turret targets, 14-inches thick, were a match for the 10-, 11-, and 12-inch guns, but afforded little margin of protection. It may be interesting to observe the work done at 1,000 yards when employing pebble powder, and when using R.L.G. in various calibres.

At 1,000 yards:—

12-inch. 25-ton gun. 85 lbs. pebble. 600 lbs. projectile.			11-inch. 25-ton gun. 85 lbs. pebble. 535 lbs. projectile.			10-inch. 18-ton gun. 70 lbs. pebble. 400 lbs. projectile.			9-inch. 12½-ton gun. 50 lbs. pebble. 250 lbs. projectile.			8-inch. 9 tons. 35 lbs. pebble. 180 lbs. projectile.			7-inch. 6½-tons. 30 lbs. pebble. 115 lbs. projectile.		
Velocity.	Total energy.	Energy per inch of shot's circumference.	Velocity.	Total energy.	Energy per inch of shot's circumference.	Velocity.	Total energy.	Energy per inch of shot's circumference.	Velocity.	Total energy.	Energy per inch of shot's circumference.	Velocity.	Total energy.	Energy per inch of shot's circumference.	Velocity.	Total energy.	Energy per inch of shot's circumference.
feet.	foot-tons.	foot-tons.	feet.	foot-tons.	foot-tons.	feet.	foot-tons.	foot-tons.	feet.	foot-tons.	foot-tons.	feet.	foot-tons.	foot-tons.	feet.	foot-tons.	foot-tons.
1,179	5,780	155	1,199	5,335	156	1,228	4,185	134·2	1,236	2,648	94·5	1,213	1,837	73·8	1,261	1,268	58·3
70 lbs. R.L.G.			70 lbs. R.L.G.			60 lbs. R.L.G.			43 lbs. R.L.G.			30 lbs. R.L.G.			22 lbs. R.L.G.		
1,108	5,108	136·4	1,149	4,852	141·4	1,177	3,842	123·3	1,175	2,393	85·4	1,161	1,682	67·6	1,196	1,141	52·5

11-*inch* 25 *ton Gun, Common Shell.*—"The same difficulty," proceeds the Report, "has been experienced with the common shell for the "11-inch gun," which were 530 lbs. weight, and contained 40-lb. bursters, and were 37·6 inches long. "The practice with common "shell (and 54 lbs. and 65 lbs. Pellet powder charges) was discontinued "on account of their extreme unsteadiness in flight, by order of the "Ordnance Select Committee who were present, 22 September, 1868. "Two rounds were fired with 65-lbs. charge to ascertain what effect the "increased charge had on the shooting; the inaccuracy of the shells "was, however, greater than before." Accordingly, 128 lbs. in weight, 10·1 inches in length, and 15·8 lbs. bursting charge are sacrificed in the common 11-inch shell, because the short bearing studs fail to give rotation to a shell such as the gun, properly rifled, could easily project. Nor is this all, for had not the walls of the original 530-lbs. shell been weakened by two rings of 1·6 inch holes ·3-inch deep, but had been strengthened by rib buttresses, it might have contained 50 lbs. of powder, instead of the 24·2 lbs., to which the 402-lbs. shell is now reduced. The difference of bursting charge, and of weight of projectile, represent part of the payment for an increasing twist, and for concentrating the effort of rotation on a short-stud bearing. Even, after making this enormous sacrifice of useful effect, we find that the practice recorded in July, 1871, showed four shot "unsteady" or "noisy" out of 30 fired; and so recently as August, 1871, we are told, "the common shell which have been supplied, have proved too weak, "and a stronger pattern has been demanded."

11-*inch Palliser Shell.*—The weak point is thus officially noticed, 7 December, 1868:—"the 11-inch Palliser shell supplied, proved too "weak to withstand the battering charge. Two shells broke up in the "gun, and three on graze. Charge 67 lbs. R.L.G. powder. Drawing "of a stronger shell demanded." "The broken shells have been re-"covered, and out of the eight fired, only two are undamaged. The “condition of the rest are as follows:—One with head broken into three pieces and off *at front row of studs*, &c. . . . the body of the shell was broken up through the base into four large pieces; this was the eighth shell fired and broke up in the gun. One with head broken off entire *at the front row of studs;* the body was broken up through the base into several large pieces. This was the seventh shell and broke up in the gun. Four with the heads broken off *entire at the front row of studs;* two of these broke at first graze, and two at last graze.”

10-*inch* 18-*ton Gun.*—This and the 9-inch 12½-ton gun are likely to be favourite naval guns. One or both will enter into all decent broadside armaments. On Scott's carriages they are handy pieces, and can be easily carried by most strongly-built ships. The 10-inch projectiles would strike a harder blow at 2,000 yards, or perforate as well at 1,500 yards, as the 9-inch at the muzzle.

At 1,500 yards:—

	10-inch, 400-lbs. shot, 60 lbs. R.L.G.	9-inch, 250-lbs. shot, 43 lbs. R.L.G.
Velocity	1,118 ft.	1,108 ft.
Total energy	3,467 ft. tons	2,128 ft. tons.
Work per inch of shot's circumference.. ..	111·2 ft. tons.	75·9 ft. tons.

As the 9-inch gun would perforate the “Lord Warden,” or “Bellerophon,” at 1,000 yards, and the “Warrior” at 2,000 yards, if not at a greater distance, it is a very suitable weapon as the standard broadside gun; whilst a few 10-inch guns would serve to dispose of 8-inch armour, and its backing at that range. Many of these guns have long been afloat, but the Navy cannot recover fired shell to examine how many studs have been wrenched out or shaved off; nor, with steam blowing off, can the “noise” of “unsteady” projectiles always be heard; nor, are observations often taken at right angles as to accuracy of the range; nor can arrivals at the target broadside-on instead of end-on be readily noted. Yet it is stated by observant Naval Officers that the studded projectiles make an intermittent puffing noise in their flight, like a locomotive steam-engine starting on its travels; and quite unlike the uniform whiz of the lead-coated shot,—every “puffer” being a wabbler and a hammerer of the bore. The breaking up of projectiles is also frequently noted. The Navy does not record, or recording, does not publish to its officers, any of its gunnery experiences. We are, therefore, driven to the War Department for official naval intelligence, scraps of which are given in those “Extracts of Artillery Proceedings,” which are circulated for the information and instruction of military men. “Keep your officers ignorant and they will obey you,” is now the received naval rendering of Earl St. Vincent's well known saying, “Keep your officers poor, and they will serve you.”

The 10-inch gun being grooved with a less increase of twist, approaching, in fact, to the uniform spiral, its shell has not been so heavily taxed as the 11-inch one, still the short bearing remains to sacrifice a good deal of its efficiency.

Passing over the experimental stages, we come to ten common shell fired with 40 lbs. R.L.G., on the 14th Febuary, 1868, "eight unsteady;" then, 19th March, ten fired with same charge, "one noisy; two a "little so." In April "a recovered 10-inch Palliser shell, fired with a "charge of 60lbs. R.L.G. powder, broke up in the gun. The bore is "badly scored, particularly No. 1 groove . . . The recovered shell "showing a tendency to break up . . . . he requests that a sufficient number of" shot be sent. It was found that "No. 1 groove "up is slightly *burred on driving edge* from muzzle to 54 inches, and "slightly scored to 78½ inches. Also deeply cut into from 32½ inches "to 41 inches." Four other grooves are "slightly burred and scored," and "the bore and grooves slightly grazed all round. . . . The "grooves Nos. 5 and 6 are *slightly dented by studs* of shot at 116 inches." On the 28th May, 1868, "one recovered shell broke up in gun," one new shell "burst in the gun" when fired with battering charges. After 385 rounds had been fired, and "two Palliser cored shot had broken up in the bore," the superintendent of experiments "states that the "bore appears a good deal injured, and fissures are beginning to "appear round the vent." After 400 rounds it is reported, 9th April, 1869, "The scoring in bore caused by the escape of gas extends from "85½ inches to 133 inches, and from 87½ inches to end of grooves "Nos. 1, 2, 3, 4; the greatest amount being from 103 inches to 120 "inches on upper part of bore and in grooves Nos. 2 and 3. The "lower part of the bore and grooves, Nos. 5, 6, 7, are slightly scored by "gas from 93 inches to 125 inches." (The bore is 145½ inches long.) "It now requires re-venting, and he thinks it should be turned over "and re-vented on present 'underside.' This being done, the gun "became unserviceable at the 534th round 'through the tube being "split in the powder chamber, evidently caused by the erosion of the "bore, consequent upon the rush of gas over the projectile.'" The cost of a new steel lining would be £515 3*s*. 8*d*. The history of this gun is that of all, and shows that erosion of the bore, above the shot and consequent hammering down upon the seat, naturally tends either to spike the gun on its own stud, or so to flatten the stud as to admit of the body of the shell touching the bore, in which case the body has to be dragged across the lands rough with fouling matter by the already overworked stud. This erosion above and hammering below are assisted by the great spaces above the shell and between the studs in the deep wide grooves; and would be partially counteracted by a system which nearly filled up narrower grooves along the whole cylindrical length of the shell.

10-*inch Palliser Shell.*—The grooves of some guns having been injured by the breaking up of projectiles in the guns, telegrams to the Mediterranean and Channel squadrons, in January and February, 1870, forbade the use of Palliser shot, even at targets, lest all should be disabled. Thirty-four 10-inch Palliser shell "fitted with strengthened "base-plugs to prevent premature breaking up," had been fired with 43 and 60 lbs. R.L.G. charges, during the last six months of 1869, from the "Hercules," four of which had broken up in the guns, one being filled with sand, and the other three with powder; and one of the latter had permanently disabled a 10-inch gun. As the projectiles could not be recovered, the exact cause of failure is unknown, but as the injury occurred, as usual, in the grooves, there can be little doubt that the shell broke up as usual through their stud-holes. The disabled gun, however, had to be returned to the arsenal, for the tube to be patched, the ship, meanwhile, being partially disarmed. Lord Gilford's report states that on the 14th December, 1869, whilst the "Hercules" was firing Palliser shell with battering charges, at a target in the Atlantic, "the A tube in one gun " was found to be split right through to the B tube at the muzzle; " the crack extends from the muzzle to the loading edge of the groove, " 10 inches up the bore, where it disappears suddenly. The B tube has " been apparently much strained, immediately above the crack in the A " tube. . . . . This gun as well as" another "lost the lower part " of the vent the same day while firing at a target. When the A tube " was split and the vent damaged, it had fired two rounds on that day " and 43 rounds in all. Also, when the vent of the other gun was " damaged, it had fired 4 rounds, or 46 in all. Only two shells broke " on the 14th December, one of which broke in" each gun. "Three " guns remain serviceable." The Director-General of Naval Ordnance remarks that "the crack in the A tube and the strained condition of " the B tube over the crack are *exactly what I should have expected.*" The Special Committee remark, 31st March, 1870: "It also appears " that a considerable proportion of *steel* shells burst prematurely in " guns when these projectiles were under trial; and, further, that " similar accidents have *frequently* happened to common shell fired with " smaller charges." Thus it would appear that this malady is of frequent occurrence and not peculiar to Palliser shell, but even extends to studded steel shell. In August, 1870, a 10-inch Palliser shell of another "latest pattern," head cast in chill and body in sand, burst prematurely in the "Hercules," on which Colonel Milward, R.A., the distinguished Superintendent, Royal Laboratory, observes, "occasionally " a shell may be expected to burst prematurely, as has always been the " case, but he thinks the evil is now reduced to a minimum." However, the outcome is that the walls were thickened and the bursting charge reduced from 10 lbs. to 6 lbs. 14 oz.

10-*inch Common Shell.*—Additional strength was secured by dispensing with the front ring of weakening studs, and some success, in firing such projectiles in this and other calibres. But the weak point still remained in the "driving" studs, and in May, 1870, out of five projectiles so fitted and fired, one broke in two at the ring of studs; and, of four recovered, one had one of the studs torn off, and the others had their studs worn from ·2 to ·3 inch. The single ring of studs was subsequently abandoned. Experiments were made at Shoeburyness in January and February, 1871, "with ten common shells strengthened " at the rear end . . . . Six of the shells have been recovered, and are " more or less 'set up.' Superintendent, Royal Laboratory, states, " although the result of the practice therein recorded is an improve- " ment on the service pattern shell, still it is not quite satisfactory." In May, 1871, five common 10-inch shell recovered at Shoeburyness were found "slightly "set up," and scored in some places by the edges "of the grooves, and in others, ground down by the lands of the gun," showing that the studs had been hammered flat by the gas escaping over the shot.

The result is, that the weakened walls of the 400-lb. 10-inch common shell, being unable to sustain this accumulated drag concentrated on one ring of studs, their thickness has been increased from 1·65 to 1·85 inches, the powder capacity being consequently reduced from 32 lbs. to 26¼ lbs. The concentration of the effort of rotation on a short bearing has, therefore, caused us the loss of at least 5¾-lbs. bursting power; its diffusion over the whole body, the abolition of the increasing twist, and the use of strengthening ribs would probably increase the bursting charge by 13¾ lbs.

Even after making this sacrifice, we learn that so recently as July, 1871, an experiment was "carried out, at Shoeburyness, to ascertain "the cause of the premature explosions of Shrapnel and common "shells." Of six common 10-inch shell recovered, there was "one "marked on base by three of the grooves in the gun;" and of fourteen 9-inch common shell, there were "three marked by the grooves of the "the guns, and two marked on 'bases by grooves of gun;'" showing that up to the last published records, the bores of guns are being hammered by their shells as they wabble their devious way out of the guns.

10-*inch Shrapnel Shell.*—On 4th March, 1871, the breaking up of 10-inch Shrapnel shell having attracted attention, the Assistant Superintendent, Royal Laboratory, states the following were fired at Shoeburyness:—"Charge 60 lbs.; 4 fired, plugged, with bursting "charge inserted; 2 broke or burst in gun, 1 fired fuzed; broke or "burst in gun; 1 fired plugged; broke or burst in gun. Charge 40 lbs.; "3 fired fuzed; 1 broke or burst in gun. He states that it is clear "that the Shrapnel shell, at present made, is quite unfit for service, "and attributes their defects to weakness. He adds that in the mean-"time instructions have been given to suspend the manufacture "and issue of 10-inch Shrapnel shell." Can we wonder that the thinner walls of Shrapnel cannot endure a concentrated effort of rotation which the thicker walls of common shell, as originally constructed, failed to sustain.

9-*inch* 12½-*ton Gun.*—Notwithstanding the large experience with this gun, it still suffers occasionally from its own projectiles, whilst the latter are still frequently reported as making an intermittent puffing noise, the result of unsteadiness in their flight, and hammering in the bore.

On the 25th September, 1868, after some years' experience of the best form of construction, and of the French or "Woolwich" system of rifling, a 9-inch gun burst violently at the first round of proof, using 53¾ lbs. of powder. There is no evidence whatever, as to the cause of this unusual occurrence. Some persons suppose the steel tube to have been defective, but, even if any evidence of this existed, other guns have enjoyed a long and useful life after their steel tubes have cracked. Thus, in 1865, a similar gun burst easily at the 400th round, with an average charge of 42·81 lbs. and a 217·33-lbs. projectile, the gun having "held together at least 14 rounds after the tube was "split, during part of which the water was seen to pass through the "gun when it was sponged." Again, another 9-inch gun, which cracked its steel tube at the 707th round, was fired 301 times subsequently before the gas escaped at the rear orifice, and 41 rounds more, or 1,049 rounds in all, before the parts of the structure began to move, and then firing ceased only because the movements of the several tubes had closed the vent. Again, another 9-inch gun, cracked its steel tube at the 203rd round of battering charges, at Tegel, near Berlin, in 1868, but the firing was continued for another 78 rounds with battering charges and 30 with reduced charges, or 108 further rounds without danger. This British-made gun was subsequently re-lined, re-proved, and re-sold for the Prussian Government. Another 9-inch gun, sold to the Austrians, cracked its steel lining at the 111th round when firing prismatic powder in 1870, without any dangerous consequences. In our own country, a 9-inch gun, rifled on the "shunt" system, burst its iron barrel at the 104th round; and being fitted with a steel tube and "Woolwich" rifling, it burst again at the 322nd round, but none of these did so with violence. Whatever faults of construction they may have had, were no doubt strained and forced out by the vicious systems of rifling adopted.

Again, an 8-inch gun used for experimental purposes, has 18 holes bored right through its sides for the admission of removable pressure gauges. It has, in that mutilated state, been fired thousands of times, and subjected to the most extraordinary strains, without showing a symptom of weakness amongst the perforated coils. Indeed, it is boasted of coil-built guns that they invariably give notice of approaching dissolution by undeniable and long continued premonitory symptoms.

It is, therefore, evident, that the violent explosive burst in September, 1868, at the very first discharge, cannot be attributable to an unknown defect in the tube or in the coils, but must have arisen from some other cause. A jam in the bore would account for it all. This jam might easily arise from the breaking up of the projectile across its stud holes; and this breaking up is proved to be one of frequent occurrence. That a broken projectile may be wedged firmly in the bore was clearly shown when the Krupp 8-inch jacketed gun was broken in two on firing at Woolwich, at the point where the broken shot wedged itself, and both gun-muzzle and shot were carried to the proof butts, where they were picked up and examined. The original Lancaster cast-iron guns with an increasing twist which blew their muzzles off, did so by the shot wedging. If it arose from the jamming of a broken up shot, then the increasing twist, short bearing, and ring of weakening stud-holes, have this extraordinary and most dangerous explosive burst at proof to answer for.

The only other explosive burst of a heavy coil gun on record, is that of a 9·22-inch "shunt" gun of the original construction, which burst explosively into 42 pieces at the 402nd round, with an average charge of 39·88 lbs. and 217·33-lbs. projectile. This, again, was obviously not due to the build of the gun, but to the stud-shot and to the squeeze of the muzzle-grip.

If then, the explosive burst be due to the rifling which causes the projectile to break up occasionally in the gun, and not, as seems clear to the steel-tube's defects, such an accident might occur at any moment between the decks of a ship, with similar disastrous results to those which occurred from the bursting of a steel gun on board the Russian frigate "Alexander Nwsgi," in 1868.

In 1869, a 9-inch gun of the "Bellerophon" had to be returned as unserviceable, the studs having wedged themselves over the edge of the grooving. Such an accident in battle would have deprived the "Bellerophon," on one broadside, of about one-sixth of her offensive power. After this ship was paid off eighteen months later, on examination, 28th January, 1871, of ten 9-inch guns, returned from the "Bellerophon," the bore of one gun was found grazed by premature explosion of projectiles; and another considerably scored by the rush of gas over the projectile, although only 22 battering and 143 full charges had been fired from it; a very small number to do so much damage!

Being re-commissioned last autumn, the "Bellerophon" had a 12½-ton gun subsequently disabled by splitting the outer coil near the muzzle, where the increasing twist has the greatest angle, and she had to change the gun at Gibraltar in November last. Venturing to fire two rounds of battering charges at general quarters last month, two other guns attempted suicide, but only succeeded in inflicting remediable injuries upon themselves. Being without official information as to the cause, I can only surmise that the "Bellorophon's" projectiles have the usual ugly trick of breaking up in the gun through their stud-holes opposite the grooves near the muzzle, where the increasing spiral has its most gun-destructive power. But if two rounds of battering charges are so gun-destructive, may we not fairly expect that in a continuous bombardment, the whole fleet would be disarmed?

On the 14th January, 1870, at the 17th round of Palliser shell of the latest pattern, fired with battering charges from the "Staunch," "a "shell either broke up or burst in the gun. Captain Boys thinks the "the former, as no explosion was perceptible." Of 50 Palliser last pattern shell fired in March, 1870, at Shoeburyness, to verify naval complaints of breaking up in the gun, "several" are recorded as "sounded unsteady" and "noisy" in flight.

We learn officially, 30th January, 1870, that "60 9-inch (Palliser) "shell of large capacity have been fired in the 'Staunch' and 'Royal "Sovereign,' and eight in the 'Minotaur.' Of these, one broke up in "the 9-inch gun of the 'Staunch,' disabling the gun, which it was "necessary to send to Woolwich for repair; and a second broke up in "a 9-inch gun of 'Royal Sovereign,' cutting into the bore deeply, "but not disabling the gun." These two accidents are ascribed to the chill given to the body of the Palliser shell, since discontinued; but I submit that this brittle material was rendered more liable to break up, in consequence of two rings of holes in the walls, and of the effort of rotation being concentrated on one of those rings; witness the statement already quoted from the official work on "Ammunition," that "a cracked projectile may be surprisingly easily divided in two, by a "blow on the stud fixed on the present system. If shot are found "split in store, the crack generally runs through stud holes." In other words, the shot break up opposite the grooves or weakest point in the bore; whereas the strongest portion of the ribbed shell is that which is opposite the groove, and none have ever broken up at the flange, though fired six times over.

The last returns show that in August, 1871, in testing the range at $5\frac{1}{10}°$, of 9-inch Palliser proof shot and Friespong chilled shot, all six fired were "noisy" or "unsteady; and of five recovered, two "Friespong were slightly burred on the driving edges (of studs); in one "(Royal Laboratory) most of rear-row slightly started;" showing that the insufficiency of rotation and shearing of the studs, still continues after all the talent which has been fruitlessly expended on the system.

8-*inch* 9-*ton Gun.*—Though this gun is happy in "not possessing a history," or at least an official one, its projectiles are popularly known afloat as "puffers" in their flight, and therefore as wabblers and hammerers in the bore. Artillery progress renders this an unnecessary weapon. The low carriage and high slide with hooked pivots to heavy deck racers, introduced by Captain Scott, enables a 12½-ton gun to be carried where a 9-ton gun was carried before, and it is, therefore, desirable to reduce the variety of calibres by ceasing to manufacture this gun as well as either the 25- or the 35-ton gun.

7-*inch* 6½-*ton Guns.*—Notwithstanding the *opinions* expressed in the report of the 7-inch gun competition, the *facts* of that report have led to the abandonment of the increasing spiral in this gun; yet, by a strange hallucination, no advantage is taken of the uniformity of twist to lengthen the bearing, either by the adoption of centering flanges or by increasing the distance between the studs;—those of the double shell being only 4·6 inches apart instead of presenting a rotating surface in each groove of 20½ inches. Thus, notwithstanding the uniformity of spiral, the projectiles are familiarly spoken of as "puffers," and the double shell as "acrobats." By the reduction of the charges from 25, 20, and 12 lbs. of R.L.G. powder to 22, 14, and 10 lbs. respectively; albeit, the projectiles are made 5 lbs. heavier, the blow at the muzzle is now 131 foot-tons less than the original both using battering charges, and no less than 264 foot-tons short of that struck by the similar Scott competitive gun. Whilst the enlargement of the bore observed in the competitive "French" gun, consequent upon the greater escape of gas and the wear of the studs, exists also in its successors. The Committee on Explosive Substances Report, January, 1871:—"In the practice with the 7-inch gun there was found to be a "difference of 30 feet per second between the muzzle-velocities given "by an old gun much scored in the bore, and a new one, when pebble "powder was used, and 70 feet when R.L.G. powder was used;" *i.e.*, a reduction of 180 foot-tons in the blow struck.

When the "Favourite" returned from the West Indies, the grooves of some of her 7-inch guns had, on examination, indications of having been over-ridden by the studs, causing a squeeze which might have been fatal to the projectile, though it did not prove so to the gun.

In December 1869, the 7-inch gun of the "Redwing," tender to the

"Cambridge," was found to have a flaw in its steel tube after firing 881 full charges; and on examination it was reported that "the A tube "is cracked through longitudinally from muzzle to 16½ inches, L of "up. The bore and grooves are slightly scored by gas all round ". . . . The gun can be repaired by the insertion of a new steel "tube, cost £186." The gun was, of course, returned to Woolwich. No doubt the gun was disabled by the breaking up of a projectile in the bore.

7-inch Palliser shot.—On the 25th January, 1870, when the "Warrior" was firing at a target in the Atlantic, "nine of Palliser's "chilled shot broke up before reaching the target, at distances varying "from close alongside to 500 or 600 yards. One of these is supposed "to have broken up before leaving the gun, as it was seen to scatter "close to the ship. The gun from which this shot was fired, was "loaded and fired twice afterwards, but on trying to load the fourth "time the shot would not go home, and on examination the rifling was "found to be slightly damaged. An impression was taken, and the "armourer having filed the groove, the gun is now" 25th January, "efficient. Six of the shot which broke up, were 7-inch Palliser chilled "shot with rounded bottoms, last pattern supplied to the ship in September last. Three were 7-inch Palliser chilled shot of the first "or oldest pattern. I may mention that three out of seven double "shell on being fired, appeared to turn over and over before reaching the target." In consequence of this report, telegrams were sent at once to the Mediterranean and Channel squadrons to discontinue the use of Palliser shot until a new pattern could be sent out.

Since the date of Captain Stirling, R.N.'s report, the acrobatic performances of the 7-inch double shell, referred to by that Officer have been rendered still more lively by placing the studs on which it is balanced *nearer* to one another. As the uniform spiral of this gun admits of 20½ inches of bearing in each groove and consequently of more rapid twist, the wilful violation of common sense committed in this case is, "one of those things no fella can understand."

The Converted 68-pounder.—The experience of this gun is small, and the published reports few. On 10th August, 1870, a converted $\frac{\text{7-inch}}{\text{68-pounder}}$ was fired, at Shoeburyness, with 28 lbs. pellet powder and a 114-lbs. "Palliser" shell. At the first round, it burst violently into seventy-six pieces, which were flung over a rectangle of 580 yards by 150 yards. This frightful explosion could only have arisen in consequence of the projectile jamming in the bore. This jamming would be facilitated by the lateral wriggling and vertical hammering action incidental to the "Woolwich" rifling; and especially so when the projectile breaks and supplies the wedges. The "Cemetery of Suicides" at the Royal Arsenal, doubtless contains many like fruits of the French system of rifling.

In March and April, 1871, we find the converted 68-pounder firing seven Palliser shell of 89·4 lbs., with 20 lbs. charges, of which "1 "noisy; 1 a little noisy; 1 a very little noisy; 2 very noisy, and 2 very noisy indeed." 1 falling 500 yards short. 17 common shell of 64½ lbs. were fired with 10- and 12-lbs. charges. "8 of the common shell have

" been recovered; studs of all are more or less burred on the driving " edges, with the exception of No. 6, the studs of which are all right. " 6 of the shells fired (in April) have been recovered; they all have their " studs burred on the driving edges. . . . With high charges of either " R.L.G., or P., the shells are unsteady, in flight, owing to the studs " being partly sheared." In September, 1871, we are told of this gun, " It would appear that at the seat of the shell the grooves are slightly " enlarged, due probably to the use of the service 64-pounder projectiles, the small studs of which would be touching one side of the " groove when loaded, and be thrown violently to the other side on " firing."

64-*pounder M.L.R.*—These guns all have uniform spirals. Some of the older ones have "shunt" grooving, but all now built or converted are prepared for French or "Woolwich" studs. That the gas escaping above the shot, erodes the bore, hammers and flattens the stud on which the shot rests, and thence leads to the stud being squeezed out of the grooves and over the lands, and hence to great and irregular strains on the gun, to inaccuracies or breaking up of the projectile, is illustrated by the records of the 64-pounder gun. For example, to take recent reports, only: in December, 1869, forty 64-pounder shell were fired by the "Excellent" without rear-studs, and most of them turned over and over. The Acting Superintendent of the Royal Laboratory reports of the shell picked up that "he believes it has overridden the rifling " altogether and come out on the lands. He has tried it in a gun, and " finds that it will very nearly go in on the lands, showing that the " studs had undergone more compression than would have been possible " if they had travelled in the grooves." Colonel Heyman, R.A. "has " examined the shell, and tested it in the pattern gun, and thinks there " is no doubt that it has overridden the rifling and come out on the " lands." The Deputy Director-General of Ordnance questions "whe- " ther harder studs can be safely used in a wrought iron barrel," lest they should spike the lower groove or bur them all. The gun being sent to Shoeburyness, and forty more shell fired, the Superintendent reports of thirty-one recovered:—" From the condition of the studs it is evident " that the turning over and unsteadiness in flight was due to the shearing " of the studs. The studs on the shells, which were steady in flight, are " in many cases almost worn through, showing that there is a very small " margin of strength in the material." In February, 1871, of forty-five 64-pounder shells with double ring of studs recovered at Shoeburyness; in one, the studs appears to have overridden the grooves; in three, as though they had nearly done so; and in the remainder, the studs are so much worn as to indicate an insufficient margin of strength.

In July, 1871, fifty rounds were fired, with three studs of harder alloy to each groove from a wrought iron 64-pounder "shunt" gun. Seven shell were "noisy" or "unsteady," yet we are told that these harder studs "have produced accuracy of shooting to a " remarkable degree, and entirely remedied the defect observed with " shell having copper studs, viz., a tendency to override the grooves." The Superintendent, Royal Gun Factories, states "that the grooves of " the gun are worn by the studs of the projectiles on the driving edge,

" and the metal is slightly burred up the bore." "The firing of the 50 " rounds from the above gun has seriously damaged one of the grooves, " rendering it liable to split." Five soft copper studs are now used for each "shunt" groove, but no more guns are being rifled on this or any other of the Armstrong systems.

Bronze Boat Guns.—Bronze was decided upon as a material for field-guns, but the erosion and wear in the grooves by the gas and the studs rendered two out of three bronze 9-pounders, tried at Aldershot, in 1870, unserviceable. The Superintendent of Gun Factories reports of one, "Metal cut away in bore by the action of gas from 46 to 53 inches " R, to up to L; deepest part ·25-inch. Grooves worn by studs of pro- " jectiles on driving side. Greatest amount of wear from 39·5 to 53 " inches in all three grooves. Gun unserviceable. Rounds fired, 243, " with projectiles, 59 blank." Of the other bronze gun rendered unserviceable, he reports to the same effect in every particular. In the third bronze gun "grooves very slightly worn by studs of projectiles. " Gun serviceable. . . . . These guns were fair castings, and he " believes they are quite as good as bronze guns produced formerly." Bronze had to be abandoned as a material for field guns in consequence of the employment of deep wide grooves, and the concentration of effort upon studs.

It was, at one time, thought desirable to utilise our large stock of smooth-bore bronze 9-pounder field guns, by rifling them to throw 20-pound shell. Two bronze guns were prepared with "Woolwich" grooving, but the studs sheared in firing, and overrode the grooves, the projectiles jammed in loading, the bores showed signs of expansion and erosion, and, after a short series of practice, both guns became unserviceable. Consequently the idea of utilizing our stock of bronze guns, had also to be abandoned owing to the vicious system of studding and grooving. The 7-pounder double shell for iron field guns were "found rather too long for good shooting." (*Ammunition*, part ii, page 96), owing to lack of rotatory power, the studs being only three inches apart, whilst 10¾ inches were available for bearing in each groove, which would have admitted of a much sharper twist. The double shell had, consequently, to be reduced.

	Length.	Weight.
From	12·15 inches	13·2 lbs.
To	11·25 ,,	11 ,,
Loss by studs	1·9 inches	2·2 lbs.

If a gaining twist be an advantage, why was it not employed to relieve these bronze guns, instead of the uniform twist which is invariably employed with guns of doubtful endurance?

Latest Practice.—After seven years' experience of the "Woolwich" rifling, every new practice table evidences new failures of rotation up to the very latest published. Several of the ablest Artillery Officers, men unbiassed and uncommitted to any system, believe that the "Woolwich" must follow the "Armstrong," and be abandoned as incapable of doing its work, whilst most destructive to the guns.

Powder Pressures.—The accident to the 35-ton gun is constantly referred to an extraordinary pressure in the powder chamber, though nobody explains how that unusual pressure arose, and as the reliance to be placed on these experiments, is open to question, it may be well to state how the pressure in the chamber is gauged.

To ascertain the maximum or initial pressure in tons per square inch in the powder chamber of guns, crusher gauges are screwed into the gun at the axis of the bore at the bottom of the chamber, into the sides of the gun opposite the centre of the charge, and at the front of the charge, and into the centre of the base of the shot. Into these four gauges prepared copper pistons are placed, and the crushing or shortening of the pistons is the measure of the pressure. These pressures are found to vary within wider limits when using R.L.G. than when using pebble or pellet powder in less quantities than 100 lbs. The following imperfect table may help for rough comparative purposes:—

Gun.	Projectile.	Charge.	Tons per square inch pressure in chamber.				Observed velocity at 50 yards.	Mean muzzle velocity.
			Gun, axis at bottom of bore.	Gun, centre of charge.	Gun, front of charge.	At centre of base of shot.		
	lbs.	lbs.					feet.	feet.
12-inch, 25 tons ..	600	85, P.	18	16·8	..	15	1,290	1,297
		67, R.L.G. .	21·9	17·8	..	19	1,162	1,168
10-inch, 18 tons ..	400	70, P.	20·2	20·1	19·9	..	1,373	1,383
		60, R.L.G. .	34·9	30·5	26·7	..	1,304	1,313
9-inch, 12½ tons ..	250	50, P.	..	..	..	10·8	..	1,420
		43, R.L.G. .	..	..	..	18·3	..	1,337
8-inch, 9 tons	180	35, P.	15·4	14·4	13·4	..	1,452	1,468
		30, R.L.G. .	29·7	25·5	21·3	..	1,361	1,375
7-inch, 6½ tons ..	115	30, P.	..	..	..	10·5	..	1,525
		22, R.L.G. .	..	..	..	16·3	..	1,435

The position of the shot in the bore of the gun when the maximum pressure was registered, as also the other pressures experienced at different stages of the shot's progress within the gun were ascertained by firing cylindrical projectiles 180 lbs. weight and 15 inches long, with 30 lbs. charges, from an 8-inch gun, 126 inches long, provided with about 21 gauges inserted in as many holes one inch in diameter in its walls. The maximum pressure with R.L.G. was 29 tons on the square inch before the shot moved one quarter of an inch, and with pebble powder it was only 15·4 tons when the shot had moved 6 inches. Yet, we are gravely told, by theorists, that the velocity of the shot, with R.L.G., is so much greater in that *first quarter of an inch*, when using an increasing spiral than with an uniform one, that the powder chamber must experience a great relief of pressure in that interval of space.

As to pebble powder, even theorists must acknowledge that the spin is given by the uniform twist before the shot reaches the point of maximum pressure. But as guns do not, as a rule, give way in the powder-chamber, but in the grooving and bore, outside the area of maximum powder-pressure, the contention is puerile and unpractical.

Distance moved through by the shot in the gun.	Velocity.		Pressure.	
	R.L.G.	Pebble.	R.L.G.	Pebble.
	feet per sec.	feet per sec.	tons per sq. in.	tons per sq. in.
¼ inch	..	..	29	1·1
1 inch	360	80	18	6·2
3 inches	510	260	15·9	13·4
6 inches	630	460	13·9	15·4
10 inches	780	650	11·8	14·2
14 inches	840	760	10	12·1
20 inches	950	900	8·2	10·1
28 inches	1,060	1,025	6·5	8·3
40 inches	1,160	1,170	4·7	6·2
56 inches	1,240	1,290	3·1	3·8
76 inches	1,305	1,350	1·7	1·9
88 inches	1,320	1,380	·8	1

The relative values of R.L.G. and of pebble powder may be seen by comparing the appointed battering charges for the service guns :—

Gun.	Projectile.	R.L.G. powder.			Pebble powder.		
		Charge.	Muzzle velocity.	Muzzle energy.	Charge.	Muzzle velocity.	Muzzle energy.
	lbs.	lbs.	feet.	foot tons.	lbs.	feet.	foot tons.
12-inch, 25 tons	600	67	1,168	5,675	85	1,297	6,999
10-inch, 18 tons	400	60	1,280	4,544	70	1,364	5,160
9-inch, 12½ tons	250	43	1,338	3,105	50	1,420	3,495
8-inch, 9 tons	180	30	1,330	2,208	35	1,413	2,492
7-inch, 6½ tons	115	22	1,435	1,643	30	1,525	1,854

The 35-*ton Gun.* (Plate XII.)—The 35-ton gun has not yet passed beyond the experimental stage, but a small crack, about twelve inches long, has occurred in the steel lining at the usual spot, viz., in the bottom groove commencing about 14 inches from its origin, where the stud on which the 700-lbs. shot rested, and was hammered down by the escaping gas. We are, however, without those official records on which I have solely relied in discussing the rifling of other guns. These guns are intended for the "Devastation" class of ships, and if they realize every expectation, may supersede the 25-ton gun, in other turret ships; and as an exceptional gun in broadside vessels. We have to balance the multiplied chances of hitting by employing two pair of eyes in aiming two 400-lb. shell, containing together 52½ lbs. of powder, from two 18-ton guns, against the concentration of effect in hitting with one 700-lb. shell, with 20⅛-lbs. bursting charge from one

35-ton gun. The authorities evidently think that the balance is in favour of concentration of effort.

The 35-ton gun is $16\frac{1}{4}$ feet long and is of Fraser construction, built up of six parts, the inner lining being a steel tube $14\frac{1}{2}$ feet long and $3\frac{1}{4}$ inches thick at the breech, tapering away to an inch less at the muzzle. It has a 12-inch bore, $13\frac{1}{2}$ feet long; rifled with 9 grooves, $11\frac{1}{4}$ feet long, $1\frac{1}{2}$ inch wide and 2 inches deep; the spiral increasing from nothing at the breech, to one turn in 35 calibres at the muzzle. This is the same maximum increasing twist which proved so fatal to the 11-inch shell, and fails to give it, as reduced, sufficient rotary motion. The gun cost about £2,500, and was designed to fire a 700-lb. projectile with 120-lbs. charge from an 11·6-inch bore; but has subsequently been increased to a 12-inch bore. We have already seen, by comparing the 11- and the 12-inch bores in the 25 gun, that though the latter makes the largest hole and has the most powerful shell, the smaller bore gives the best penetration. The resistance of the air is in the proportion of the squares of the diameters; and the facility of perforation is inversely as the diameters. On the other hand, a larger bore consumes more powder and brings less strain on the gun. The effect of increasing the calibre is very apparent in the 25 ton guns, both firing 85 lbs. of pebble powder; but the 12-inch gun throwing a 600-lbs. shot, and the 11-inch gun a 530-lb. shot. The maximum pressure in the 12-inch gun is only 18 tons; whereas in the 11-inch gun it is $29\frac{1}{2}$ tons, or nearly one-third more strain; yet the velocities are nearly alike, owing to the greater consumption of powder in the larger bore. But there is a limit to the extra consumption of powder due to this increase of diameter of bore caused by the length of the gun being regulated by its weight and by the convenience of muzzle loading on shipboard. It is a balance of qualities, a sacrifice of extra shell-power on the one hand, and of extra perforation on the other, whilst the "Woolwich" rifling will not rotate either shell, but causes slightly less sacrifice of shell-power with the larger calibre and shorter projectile. Passing to the accident, we find that before the "incipient crack" occurred in the steel lining, the experimental gun fired the following 68 charges of pebble powder with 700-lb. projectiles:—

With an 11·6 inch bore	.. ..	4	75 lbs.
,, ,,	.. ..	2	100 lbs.
,, ,,	.. ..	16	110 lbs.
,, ,,	.. ..	6	115 lbs.
,, ,,	.. ..	6	120 lbs.
,, ,,	.. ..	1	130 lbs.
		—	
		35 rounds.	
With a 12-inch bore	.. ..	6	110 lbs.
,, ,,	.. ..	13	115 lbs.
,, ,,	.. ..	14	120 lbs.
		—	
		33 rounds.	
		—	
Total with both bores	..	68 rounds.	

Making about $3\frac{1}{2}$ tons of pebble powder and over 21 tons of shot.

Five rounds with 110-lbs. charges have been fired since the appearance of the "incipient crack" without any extension of the injury.

The initial velocity reached its maximum as an 11·6-inch gun, with 120-lb. charges, when it was 1,370 feet per second, with a pressure on the powder chamber of 47 tons per square inch; whilst it fell off to 1,346 feet with a 130-lb. charge, though it gave 63 tons pressure on the base of the projectile, showing that the extra powder was unconsumed, or that the exit of the shot was impeded. Artillerists recognise two kinds of powder-pressures, viz., first, that which is general or usual, and which never exceeds 40 tons on the square inch; and 2nd, local pressures, the result of violent oscillations of the ignited gas, the cause and strength of which are unknown. The combined pressures were 47 tons on the square inch with 120-lb. charges in the 11·6-inch bore, but these were reduced to about 35 tons in the 12-inch bore. Suddenly, at the eighteenth 120-lb. charge, the extraordinary internal pressure of 66 tons per square inch was registered in the powder chamber; and the steel tube being calculated to withstand only 55 tons, an "incipient crack" took place in the bottom groove near the seat of the shot. I have not seen all the registered pressures, but those of the last four 120-lb. charges varied from 40 to 66 tons, the initial velocity with 46·8 tons pressure being six feet more than when the pressure was 66 tons. The muzzle velocity and maximum pressures given by the last four 120-lb. pebble-powder charges in the 12-inch bore, with 700-lb. projectiles were:—

Velocity.	Total work.	Maximum powder—pressures at		
		Axis of gun.	Vent.	Projectile.
1,366 feet.	9,059 foot-tons.	46·8 tons.	35·2 tons.	45·4 tons.
1,360 „	8,973 „	66· „	42·6 „	53·2 „
1,334 „	8,639 „	44·6 „	34·2 „	46·8 „
1,334 „	8,639 „	37·6 „	27· „	39·6 „
Mean = 1,348 feet.	8,828 „	48·7 „	34·7 „	46·2 „

The muzzle-velocity and pressures with smaller charges of pebble powder are said not to present the same variety; probably because the effort of the shot to escape from them is more successful. Some of those for the 115-lbs. and 110-lbs. charges in the 12-inch bore, are:—

Charges.	Velocity.	Total work.	Maximum powder—pressures at		
			Axis of gun.	Vent.	Projectile.
115 lbs.	1,316 feet.	8,408 foot-tons.	44·5 tons.	29·6 tons.	42·4 tons.
115 lbs.	1,288 „	8,047 „	22·5 „	19·9 „	18·5 „
110 lbs.	1,272 „	7,853 „	20·1 „	19·7 „	17·2 „

The service charge is, I believe, now fixed at 110 lbs., which, should it give, as is said, 1,300 feet initial velocity, would inflict a total blow of 8,205 foot-tons at the muzzle. Returning to the last four

120-lbs. charges, and the crack, let us ask, why did the greatest pressure give the lesser velocity, if the exit of the shot was not impeded? Why this variation in the powder-pressure at all? As the shot acts towards the powder-chamber like the stopper of a bottle, or the valve of a steam boiler, the first movement of which relieves the maximum pressure, it is evident that this cannot extend along the bore outside the position of the shot at the moment. When the shot moves six inches from its seat, the pressure reaches its maximum, and when the shot passes beyond that point the pressure is relieved. Evidently the maximum pressure cannot extend beyond the base of the shot at that point, and injuries arising directly from such a cause must occur within six inches of the powder chamber. But the crack begins about 14 inches from the chamber, and ends about 26 inches from it. Again, the 10-inch, 18-ton gun now in use to measure powder pressures, which has 18 inch holes bored through its walls, has repeatedly sustained violent R.L.G. strains exceeding 60 tons on the square inch, and is quite uninjured. The question, then, is still in obscurity and remains unanswered:—Why did this sudden increase of the powder pressure take place? Was the pressure in the chamber the cause, or the result of the accident, which occurred at least 8 inches (or, to the centre of crack 14 inches) outside the point to which the maximum powder pressure extends?

Three theories have been started:—

1st, that the bottom stud flattened by the blow above the shot caused by the escaping gas, overrode the groove, causing a squeeze which delayed its exit, and lead to an accumulation of gas in the powder chamber. These shots were not marked before firing, and have not been picked up and examined since.

2nd. That the wabble caused by balancing the shot on two studs, and the irregular action of the powder above it, due to non-centering of the projectile, wrenched out or sheared the stud and set up a motion of the shot across the bore, which enhanced the difficulty of its escape.

3rd. That pebble powder developes some new quality when ignited in 120-lb. charges which it does not possess when fired in quantities of 100 lbs. and under. This new quality is assumed to consist, 1st, in variable and uncertain pressures, and 2nd, in allowing the shot to proceed further out of the bore before the maximum pressure is registered. Now the centering ribbed 7-inch shot attained, with 2° elevation, Admiral Key's extreme fighting of 1,500 yards range with 20 lbs. of powder, whilst the studded French or "Woolwich" one required 25 lbs. to do so. Supposing those proportions to hold good with large calibres, the 700-lb. projectile, if provided with centering ribs, narrow and shallow grooves, and a uniform twist, would be thrown with the 100-lb. uniform-pressure pebble powder the same distance that it is now thrown with the 120-lbs. erratic-pressure and self-destructive charge, and so the "incipient crack" would not have arisen.

Naval loss.—In dealing with the question of rifling, I have set before you, almost exclusively, official facts. These show that we are sacrificing much of the efficiency of our magnificent guns to a vicious system, in which the effort of rotation is concentrated upon the smallest possible bearing, that small bearing being necessitated by an increasing spiral, and that increasing spiral being opposed to recorded experiments, the most fatal suicidal results being those obtained where the purest form of gaining twist is employed. There has been an utter failure to secure adequate rotation from the service system; and to the fallacious theories on which it rests, we can trace in official records, loss of practical utility in every gun from the 9-pr. up to the 35-ton gun, and, that, whether constructed of bronze, iron, or steel. As a naval question, it especially concerns us, not only because the non-penetration of a single projectile owing to its wabbling may be a most serious matter in action, and the disabling of a gun by its own shell, be fatal to victory; but because we have permanently crippled the power of our shell by concentrating upon a small and weakened portion of their walls the whole effort of rotation. The common shell proposed for the 12-inch 35-ton gun contains only 20 lbs. 1½ oz., instead of the 45½-lbs. bursting charge in the original 12-inch common shell for the 25-ton gun. Again:—

Pattern.	12-inch, 25-ton gun, common shell.				11-inch, 25-ton gun, common shell.				10-inch, 18-ton gun, common shell.			
	Length.		Weight.	Bursting charge.	Length.		Weight.	Bursting charge.	Length.		Weight.	Bursting charge.
	Body.	Total.			Body.	Total.			Body.	Total.		
	in.	in.	lbs.	lbs.	in.	in.	lbs.	lbs.	in.	in.	lbs.	lbs.
Original	23·85	36·15	600	45½	26·525	37·6	530	40	..	33·8	400	32
Present	17·8	30	495	35	16·425	27·5	402	24·2	22·56	32·5	400	26¼
Lost by studs..	6·05	6·15	105	10½	10.1	10·1	128	15·8	..	1·3	..	5¾

Variety of Projectiles.—Great variety of projectiles are objectionable in military operations, chiefly because of the difficulties of carriage; but in naval actions, chiefly because it is not always possible to say when loading a gun what sort of vessel it is to be fired at. We have two Palliser projectiles, with chilled heads, alike in weight, and nearly alike in all other respects, viz., the cored shot, and the shell, the cavity in which is nearly the same size. The Palliser shell, moreover, is not provided with a fuze, so that its bursting after penetrating the unarmoured portion of an iron ship is doubtful; and after penetrating the unarmoured portion of a wooden ship its *not* bursting is certain. The present Director-General of Naval Ordnance thinks it best "to retain "only one nature of armour-piercing projectile, viz., the present pattern "shell, at east for 10- and 12-inch guns." To this, I would add, that a concussion fuze should be employed, without which the "Palliser shell" does not burst when hitting the unarmoured portions of ships.

The common shell is the more generally useful projectile; and it is most pitiable to observe how its efficacy is sacrificed, owing to the impossibility of giving adequate rotation, not only to shell of proper powder capacity, but to any projectile whatever with an increasing spiral and consequent short bearing.

We have also "shrapnel shells" which are not to be used under 500 yards, and "case shot" which are not to be used over 400 yards, a space of impunity 100 yards broad, existing between. As hostile naval forces are not always stationary, distances may vary between the loading and the firing of the gun, thus, introducing a further complication, which we commend to the attention of naval gunners.

In conclusion, I am sensible of having omitted the consideration of many most important matters in connection with "naval gunnery," but I have thought it better to concentrate attention on the questions of endurance, both of the gun and of the projectile, and of the powder-capacity of the latter, so far as those are affected by the mode of rifling, and of the relative penetration as measured by the initial velocities of similar projectiles, these being essentially naval points; and to support the views expressed by quoting the *ipsissima verba* of official or authoritative documents. This has led me to dwell on particular points at greater length than if I had merely placed before you my own unsupported opinions. I invite my naval brethren especially to the careful study of the facts produced, in the hope that the result may conduce to the honour and to the defence of our common country, and to the well-being of that noble profession to which all my powers of mind and body were devoted for twenty-five years, and in the service of which I had once fondly hoped to have spent the best of my days. Whatever Orders in Council may determine, depend upon it, that ignorance is not the handmaid of modern seamanship, but that an intelligent study of all sciences underlying the naval profession is a "*sine qua non*" for the efficient commanding of modern war-ships by those to whom the country must entrust its "*outer line of defence*." Amongst the foremost of these sciences is that pertaining to *artillery*, the principles of which, notwithstanding the other great improvements introduced by the two successive Directors-General of Naval Ordnance, are altogether ignored in the theoretic education of even gunnery officers. Until ignorant impatience of such theoretical studies is banished from the navy, we must not wonder if—

> " blind and naked ignorance
> " Delivers brawling judgments unashamed,
> " On all things all day long."

Whilst we must expect, despite our greater experience, to be far behind military gunners in information, both in the opinion of our own more intelligent members and in that of the world; and that our opinions should carry small weight in the choice of the weapons which we receive, almost unquestioned from, confessedly, able and learned landsmen. Let naval gunners but add to their experience, knowledge; then, and then only, will they be competent to distinguish between false surmises and true principles, and to share with talented Artillery Officers the responsibility, the labour, and the intelligence required to perfect our magnificent guns, so shall we—

" . . . . send forth
"From far, with thundering noise, among our foes
"Such implements of mischief as shall dash
"To pieces, and o'erwhelm, whatever stands
"Adverse."

Would that I might truly add—

"Nor long shall be our labour; yet ere dawn
"Effect shall end our wish."

Captain SELWYN, R.N.: Gentlemen, I should have waited for some expression of opinion from those who have been more recently acquainted with artillery questions than I am; but the Chairman has induced me to stand up. That being so, and not having the pleasure of seeing to-night Captain Scott, whose name has been so frequently and so honourably mentioned during the most able lecture Captain Dawson has given us, I feel called upon to do the best I can for the tenth year in defence of a system which I, in common with Captain Scott and others, have urged against every other system of rifling known. Not because we had a particular fancy for that system; not because we were partisans of a particular system, but because we saw that the involved principles were those of true mechanics; because we knew that where you throw a large amount of friction on a small surface you cannot get a satisfactory effect; because we foresaw that the immediate result of soft studs of a small area being driven at high velocities, must necessarily be, the bruising of the studs, probably the breaking up of the shot, the destruction of the gun, and the loss of all accuracy. These results have been put before you by Captain Dawson in the most lucid manner. You see, very clearly now, how it is not sufficient that we should rely on those vague theories which are supported by persons who, not being themselves artillerists originally, only become so after a certain time, and by that popular process of the present day, the method of trial and error, in other words, the trying of all possible ways of doing the thing wrongly, before we arrive at, or consider even the right. I think, had we resorted even to the great body of engineers of England, they could have told us from their experience of steam machinery;—and they did in other institutions tell us pretty nearly,—that we were proceeding in the wrong direction, when, first, we relied on the attachment of lead coating to iron shot; when, secondly, we relied on putting small holes in shells which were not intended to break up before the powder charge acted upon them, and then caused them not to break up at any other than the weakest points; that we were not proceeding in the right direction again, when we adopted all sorts of forms of building up guns, without considering closely and accurately,—as we have not yet done,—the true principle of building guns by casting; I say, even to-day, that in Russia they are ahead of us in this question. They have taken the common cast-iron gun; they have steeled the inside by a very simple process; they have reduced the outside to the condition of wrought-iron; and they have, thereby, secured the true mathematical conditions of strain under which iron, whether it be called steel or iron, can best resist the strain to which we propose to submit it. We prefer, in cartridges, resorting to a little bit of iron, a little bit of brass, a little bit of tin, a small quantity of pulp, and several other things, to the simplicity of stamping from sheet metal. In guns we prefer to resort to the laborious process of building up sundry large bits of iron and steel, to the simplicity of a well cast and perfect gun. I do not think with Captain Dawson that we have the best guns; I should be very sorry to think so. I think it would be a very great stain on our mechanical knowledge if we did not know how to put metal together, and so to temper it that it should receive and resist its proper strains, without turning up separate parts in the lathe, and putting them together. I do look forward yet to the time, when even the guns will be improved. But, to pass from that subject altogether, to the more legitimate subject of the lecture, that of rifling, I do not think it needs very many comments on my part to point out that Captain Dawson has arrived,—and he has proved to you that he has arrived, on the mere showing of official records,—at the fact, that we ought not to have rejected, in favour of a foreign plan, which professedly only imitated in a certain degree the "centreing of the shot," and the true rotation which was given by Captain Scott's original plans—plans carefully thought out by an educated and highly intelligent Gunnery Officer of great experience ; that we ought not to have passed through by "trial and error," the lead-coating and the multigroove system, the shunt system, and the polygonal system, which I have often spoken of in this theatre. I have great respect for Sir Joseph Whitworth as a mechanic ; but not for him as an artillerist. I happened to be in Brazil the year before last, and a Brazilian Officer there, the best authority they have on guns, gave me the results of his experience of the Whitworth guns. He said, "The gun has never been fired against an enemy, but has killed twelve of our own men." Now, that was done simply from the fact that, as even such a mechanical authority might be expected to do, Sir Joseph had ignored the fact that in these curiously constructed grooves, the discharged powder was very likely to leave sparks. It did so leave sparks, and in loading the gun blew the gunners away from the muzzle. But this is nothing to what follows as a consequence. I must draw your attention to the fact, that the whole of Captain Dawson's lecture has shown us, that those tools on which we have been in the habit of relying, on which I am sure Sir George Sartorius will bear me out in saying, he has always relied without the slightest fear or the slightest care, now fail us. Formerly, if we threw our guns overboard for a year, and took them up again, they were as good as they were before. If we subjected them to all kinds of malfeasance in loading, by Jack's anxiety to put a great amount of metal into his enemy, it did not matter what we did to them, they were always good. But here is a picture before us, in which we see a fleet manned and sent to sea, exercising the seamen in the use of these guns ; and the very exercise has broken down the guns before they came into action. And we are asked to form the first line of defence ! with ineffective guns—with guns in which no naval gunner can put his faith. Is not this a picture which is worth thinking of, which conveys facts worth working at closely and consistently ? Is it not a thing in which there should be no concealment on any part, no desire to conceal ? I do not see anything more expressed than these doubts which, according to Captain Dawson, have been thrown out, whether the powder may not have done it, or whether anything else might not have done it, except the thing that did do it. We want to know what did do it. We do not want to have any doubt on the subject. We want exhaustive experiments, easily performed, with the acres of guns of all natures which, to use a compendious term, are now obsolete. We should really try experiments to find out what ought to have been done. But we do not try these experiments. We try to find out how many things ought not to be done. "Trial and error," that is our constant course. It has been so with iron ships, and it is so with guns. Until we honestly confess that studs picked up by dozens are not in a satisfactory state, and should not be used, as compared with ribs that have never shown such failures, we shall never go ahead at all. We shall be exactly in the state, when war breaks out, of trying experiments, experiments thoroughly inconclusive in themselves, as widely wrong as those are likely to be which are based on a theory as to increasing the spiral. If I was to go into theory, I would beg you to observe that, as a shot starts from a position of rest, by progressive increments only acquiring the terminal velocity, the spirals ought on that theory to be decreasing, because the shot is passing over more feet in each moment of time, from the moment it starts to the moment it leaves the muzzle ; and for the twist to remain the same proportionally, the spiral of the rifling ought to decrease rather than increase. Mathematically speaking, that would be the case. But we are contented to have less mathematical correctness if we can ensure greater general results in practice. That result in practice is shown wherever you only seek a moderate effect as to great range. And great range has run away with an enormous number of people, both in small arms and in artillery. It is, I do not fear to say, one of the greatest mistakes of the day. It is a thing which will lead to the expenditure of more rounds of ammunition uselessly, than anything else. It is a thing which will lead to more demoralisation of troops on land, and more uncertain work at sea, than anything you can do. Do not go in for it. Hit your blow hard at a short distance. Wait until you have got within that distance. Do not make the mistake of allowing each man to hope he may hit a mosquito five miles off. I cannot speak too strongly on this subject, for I feel that the whole results of our gunnery depends on the adoption of the most simple principle of rifling. I am even almost inclined to say, that the smooth-bores,—take them out and out,—will beat in practical results, the rifled gun with the very best range. I want to see the rifling that will give us, under all conditions and at all times, quite equal results with the smooth-bores. I am not prepared to say that you can fire great powder charges contained in very long shot with great accuracy at very long ranges, from the smooth-bore; I know that you cannot. But I want you to consider the balance of advantages, and to consider it closely. I want you to consider why it was that rifling having been known, having been tried many hundred years ago, was abandoned, and the smooth-bore was brought back. It was not done for nothing. We must not credit our ancestors with such a great amount of folly as to suppose they did all these things, realised an advantage, and then abandoned it. It was because they did not find the advantages which were theoretically to be obtained. And not among the least of these, remark, is that ricochet firing which has been so often adverted to here, and which has not certainly been obtainable from the best rifled gun, whether on land or at sea. I want the gun which will stand the most hard wear, the most wear and tear with the least damage, which will give the best general results, and which will be ready at all times for action; and which will not be probably liable in the heat of action to a report from the Gunnery Officer to the Commanding Officer, "three guns are disabled, and you have only got four." Just picture to yourself the Commanding Officer of a ship receiving such a report. What would be the feeling on board one of our finest ships if such an accident, as has been brought before us, were to occur in that ship? How should we face our country? Would they believe us when we told them that, because you gave us that gun, we were not able to fight a good action! They would say, "you ought to have fought with your teeth, you ought to have done anything." But, unfortunately we are but men, and even at sea we cannot do more than we can do. I want to press this strongly on the Institution, that it is only by means of exhaustive experiments that these matters can be decided, that such exhaustive experiments must necessarily cost money, and ought to come under the observation of the very best persons to be found in the country on such subjects; that no man ought to be admitted as an authority, nor his views entertained, who has once been proved to be the happy possessor of a petted fallacy. Neither excuse nor ingenious theories ought to be admitted when a man has proved that he did not know how to do it. Let us find out by close examination those men who can do it. Let us encourage them. Do not let us cut down £12,000 to £2,000 yearly, for experiments, and then find fault with the results of an experiment on an ironclad that cost half a million. Do not let us say that the economy of "modified pens" is to be carried into the guns of the Navy. Such things may be worthy of an economist who only sees things through the eyes of a commercial man. They are totally and utterly unworthy of the patriot who seeks the honour and the glory of his country, who says that no expenditure is useless, or is thrown away, if the results obtained, will ensure the lasting glory and status of this country. This has not so been; this is not being done. To-day money is grudged for experiments; it is cast away with open hands for the purpose of vague theories on human perfectibility. I do press on this Institution the fact that they are in possession of the field, if they choose closely and strongly to urge on the Government of the day, that to practice alone, not as distinct from, but as part and parcel of science, they must look for the carrying out of the work of the country; and that cautious experiment combining the two cannot be too sedulously encouraged. Then, I say that this and other institutions may so insist upon this, may so bring it before, and home to, the people of this country, that no Government can resist the tide of experiment that would set in, and which would repay us fully in its results.

Captain Colomb, R.N.: I would suggest that if there is any gentleman here, who knows the other side of the question with regard to the Scott gun, he should give us his views. At present we have only the strongest arguments and the strongest facts quoted to us on one side; and a member like myself who is not very conversant with these subjects, is left in a semi-amazed state on hearing only that one side. There must be another side, I imagine of the question; and, I should say, there must be some gentlemen present who could give it to us. In the year 1859 or thereabouts, I happened to be at Shoeburyness, when the first rifled field gun on the French pattern was tried. It was tried against the Armstrong gun in my presence, and there was nothing but the most complete condemnation of the stud-system shown on that occasion—the system which I have since seen adopted. I merely state it as a fact which came under my own notice.

Commander DAWSON: It is somewhat disappointing, after spending some three or four months, on what has been a very interesting occupation, to find when one comes before an Institution like this, composed of a number of naval and military officers, that one's labours are so far not appreciated, as that no person thinks it worth while to take the opposite view. It is a little disappointing, because I quite agree with my friend Captain Colomb, that there ought to be another side; I know there is another side, but it is not a side which I care to take up. It is a side of speculative hypothesis, and delusive mathematical formulas, the elements of which are pure assumptions. It is well known to mathematicians, that erroneous premises will lead to the most astoundingly fallacious results. There is indeed, a very simple algebraic equation by which it can be clearly proved that nothing is equal to anything. It is with the premises alone that I have dealt. In doing so, I have confined myself simply to *well-ascertained facts*, authenticated by their appearance in official publications. There are speculative opinions in those publications, but I have not chosen to quote them, because those opinions are sometimes based on insufficient evidence, and are often opposed to one another, and to the facts appended to the same documents. There are in the numerous official Reports, which I have studied, Tables of Practice, issuing from Shoeburyness; which I take to be absolutely true. For example, looking into the Report of the only heavy gun competition in this country, which was written seven or eight years ago, when there was not the amount of experimental experience and information on the subject which we have now; I find that the prophetic utterances which were then issued, turned out altogether false, being falsified by the events. That being the case, I have not deemed it worth my while to quote those opinions, or to contradict them, as I did not wish to hurt anybody's feelings by referring to false prophecies. But in justice to the other, or speculative side, it will be seen that in the Report of the 7-inch gun competition (1865), the opinions contrast extraordinarily with its own facts; and the prophecies with the events. Contrast for instance Art. 9, p. 3, in which both the Scott and the French systems are regarded as equal in endurance, with the "Report of the Inspector of Ordnance," page 20–21, where it is said the French gun, "should in future be fired under precaution," and the details of the injuries are given; whilst of the Scott, "there is no apparent expansion in bore, nor alteration in the dents since last examination." Contrast again the prophecy p. 3 that "there need be no fear of the breaking down "of the grooving by the abrasion of the studs," with the constant occurrence of this wear. Contrast the ease of loading reported p. 3, with the Shoeburyness Report p. 26, where a metal rammer had to be repeatedly used, to force home the French shot. Contrast the statement Art. 20, p. 6, that, except in firing round shot, the French gun "is in every other respect equal or superior to" the Scott; with the statement Art. 13, p. 4, that "the French system has somewhat decidedly the "lowest velocities," striking a muzzle blow 133 foot-tons less than the Scott; and, Art. 21, p. 7, that "the French gun is but inferior up to 5°," *i.e.* up to 2,500 yards, or inferior up to 1,000 yards beyond useful fighting distance; and with the statement, Art. 6, p. 15, "the single point upon which the Scott system may be practically "superior to the French is in the cheapness of its projectiles," the Scott shell being £80 per thousand and the shot £92 per thousand cheaper; and with the Report of the same Committee that "Scott's projectiles have the further merit of being of "convenient exterior form, easy to pile, but little liable to injury and simple in "manufacture;" and "Scott's form is the most advantageous for a shell in respect "to capacity, the Committee give precedence in respect to the efficiency of the projectile, to Commander Scott." But the 7-inch guns, says the Report, Art. 22, p. 7, are "essentially shot guns"!!! Compare the prophecy, "nor do the Committee think "it probable that any disparity will appear in their performance with longer projectiles," with their report, 4th August, 1865, that the 7-inch double "shell roll "considerably, owing to their great length." Contrast the statement Art. 13, p. 18, that the advantage of the increasing spiral "can best be realized with a short bearing on two points," with the Shoeburyness Report p. 40, and again p. 42, that "the recovered shells show that the small stud did not touch the driving edge of "the groove;" and with the now well ascertained fact that the guiding studs do not share the effort of rotation with the driving ones, but simply serve to mitigate the wriggling motion of the projectile in the bore. Contrast the statement Art. 4, p. 15, "the shells recovered after being fired from the other two guns were "apparently uninjured," with the Shoeburyness Report, p. 36, that "40 French "shells have been recovered," of which 28, or 70 per cent., had their studs "moved" or torn out, whilst, p. 55, six loaded Scott shell were re-fired which "were recovered "shells, and fired in the presence of the Ordnance Select Committee, none of them "burst," and in the previous cast-iron rifled 32-pounder competition, Scott's recovered shells were fired over again an average of six times. Compare again the statement, Art. 4, p. 15, that "five of the recovered shells were subsequently fired "full of powder, from each of the two guns," with the Shoeburyness Tables, p. 36, which show that the only five loaded French shells fired, were original and not recovered projectiles. Again, contrast the eloquent and eulogistic prophecy upon Sir William Armstrong's "shunt" system Art. 16. p. 19, with the actual event, viz., its utter abandonment. See how the arithmetical errors, in the Committee's summary, pp. 5, 8, 9 of the Shoeburyness Tables of practice, pp. 24, 45, &c., invariably favour the French gun; and how the delusive ranges at 4,500 yards are meaned with those at fighting ranges, p. 5; and how the ranges obtained with 110-lb. shot, (which weight had been fixed "in order that the very best shooting qualities of the guns might be developed,") are omitted from the body of the Report, except those with 12-lb. charges, the superiority of which in Scott's gun was least overwhelming, but without a comment as to Scott's enormously greater force of blow at the muzzle. A consideration of these things will show why I discard opinions so opposed to one another and to the facts on which they are supposed to be based. Truth can only be based on fact. I beg those who may be seekers after gunnery truth, not to rest on opinions however authoritative, but to go back to the experimental data on which they are based. Dogmatic gunnery is not scientific gunnery—the one is a system of guesses, the other a digest of accumulated experiment. Science formulates existing laws of nature, but it does not create them. There is "a science falsely so called," but true science is simply the art of expressing absolute ascertained facts in precise language,—it is not guess work, but known truth. Look, then, for facts, and not for guesses.

I am sorry that the extreme length to which the subject led me, obliged part of the lecture to be given *viva voce;* but when it comes out in print those who will do me the honour to read it, will find that throughout, step by step, it consists of a string of quotations from different official reports, giving with them figures, which it is no use reading out, as people cannot follow figures with their ears, though when seen with the eyes, they will be understood and appreciated. Now, referring to Captain Selwyn's remarks, my statement that we have the most magnificent guns in existence, does not prejudice the question that better guns might not hereafter be found. On that I express no opinion. I came here to state established facts, not prophetic opinions. I have searched, as far as I can, for authenticated information of those systems that have been officially tried under like conditions, conditions that I look upon as reliable; and such facts have alone been brought before you to-night. But I have rejected those opinions of which I cannot actually find the basis of well-authenticated experimental facts on which they are founded. It is not sufficient for me that it is reported, I do not care on which side it is, that somebody or other has produced a magnificent gun in this country or in some distant land; I must have the fact authenticated in some way by recorded experience before relying upon it. Otherwise I should have gone into no end of speculative reasoning, which would have taken a whole volume to deal with every debateable point. Another point referred to by Captain Selwyn was that our smooth-bore guns show greater accuracy when in lively motion at sea than our rifled guns. That is a well-established and undoubted fact. But when we come to inquire why the fact is so, we must not look inside the guns for the cause, but outside them. It is ascribable to the sighting, and to ignorance of the distance. I was not able to go into the point to-night, but you will find it explained in my paper that the sighting of rifled guns is most inimical to accuracy. As there are military men present, I may, perhaps, be permitted to explain that the seaman gunner aiming a gun at sea must stand six or eight feet behind the rear-sight. And in order to see the object in line with the outer sight, his eye must pass a certain vertical distance above the rear-sight. The amount of vertical height between the rear-sight and the line of vision, depends upon the state of the weather and upon the motion of the ship. When the ship is steady, in cloudy weather it will probably be $\frac{1}{10}$th or $\frac{2}{10}$ths of an inch. When the ship is very lively, it may be half an inch. At all known distances, all considerable errors in shooting at sea are dependent upon the height that the line of vision passes above the rear-sight. Now, let us take a given vertical height of visual error, say half an inch. The effect that half-an-inch will have upon the range, depends upon the distance between the rear-sight and the fore-sight. Bring the fore-sight within a few inches of the rear-sight, and that vertical half-inch of visual error will cause some thousands of yards increase of range. Push that fore-sight away as far as you possibly can from the rear-sight, and the same visual error will mean at 1,000 yards range, perhaps, 90 yards error with a 68-pounder smooth-bore. Put then, a 68-pounder alongside one of our beautiful nine-inch 12½ ton guns on the same lively platform, and let the same vertical visual error of half-an-inch be made with both; it will cause at 1,000 yards distance, an error in range of 380 yards with the rifled gun, but only 90 yards with the smooth bore, if the muzzle sight be employed. That explains a great deal of the mystery. Rifling has comparatively little to do with inaccurate shooting at sea; it is simply a matter of knowledge of the exact distance, and a better system of sighting. Captain Selwyn has referred to the absence of intelligent, painstaking, and exact experiments conducted by men of science, so as to lay the foundation of true principles, and substitute scientific gunnery for that dogmatic system of guesses, which forms the ground-work of so much artillery teaching, and of that "rule of thumb" which constitutes the most important artillery formula. The necessary experiments to determine the merits of the increasing and the uniform spiral, on which the whole ruinous short-bearing system hinges, could be tried at a very small expense. Let two or more 25-ton blocks be bored up to nine or ten-inch bores, one with *uniform spiral*, the other with the *increasing spiral*, and others with various lengths and kinds of bearings, and let any number of experiments be tried. And after the experiments have been exhausted, put in the boring machine, and bore them up to the proper service calibre of eleven inches. The cost would be small, consisting solely of the actual powder and shot used, and the difference of expense in twice boring out instead of once, which would be a mere trifle. A few thousand pounds would exhaust the whole outlay from beginning to end. The proportion which this outlay bears to the three million expended on the now obsolete Armstrong lead-coated system, to the large sums sunk in the "Shunt" system, and to the millions which have been lavished during the last seven years on the yet most suicidal French system, is exceedingly small. But we want the intelligence, the patience, and the scientific impartiality which is to direct such experimental researches. So long as people are content to go on theorising upon hypothesis, for which they have not the slightest basis whatever, they can't understand the necessity for exact comparative experiment, and they won't take the trouble of laying a sure foundation of experimental facts. Captain Selwyn has also referred to the part that this Institution might play in questions of this kind. I think we ought to be reminded that it was this Institution which saved the country from squandering many more millions of money on false systems of artillery which would most assuredly have stranded both our land and sea forces in national disasters. The leading and active part which this Institution took in undermining, and finally overthrowing the lead-coated system, and the "shunt" system, should not be forgotten; and I hope that this Institution may also help to overthrow the present suicidal rifle system, which has disabled eleven guns on shipboard in the last three years, besides a larger number self-destroyed at Woolwich and Shoeburyness and now lying in the suicide's cemetery unburied, though not unwept or unsung, at the doors of the Royal Gun Factory at Woolwich.

The CHAIRMAN: I should like to ask one question. If I understand you rightly it would be quite possible to improve, and make as perfect as you see your way to, all our existing guns, by taking out their steel tubes, boring them up, and rifling them on some other principle?

Commander Dawson: The cost of doing so to the 35-ton gun would be about £700. It would be much less for smaller guns.

The Chairman: The original cost of the 35-ton gun being how much?

Commander Dawson: £2,500 at arsenal prices. As you buy it from Elswick, it would be about £3,500.

The Chairman: Gentlemen, I am sure you will return your hearty thanks to Captain Dawson for the very able paper which he has read to us to-night.

Evening Meeting.

Monday, April 15, 1872.

Admiral the Earl of LAUDERDALE, K.C.B., &c., &c., in the Chair.

NAMES of MEMBERS who joined the Institution between the 9th and 15th April, 1872.

ANNUAL.

Matheson, Duncan, Lieut. 6th Inniskilling Dragoons.
Miles, Thomas G., Major North Durham Militia.
Reasch, F. Carne, Lieut. 6th Dragoon Guards.
Farrer, W. D. M. C. P., Lieut. Grenadier Guards.
Wandesforde, C. H. B. C., Lieut. Grenadier Guards.
Aitken, W. D., Col. Royal Artillery.
Stopford, Hon. F. W., Lieut. Grenadier Guards.
Marsham, H. S., Lieut. 60th Royal Rifles.

MOUNTING AND WORKING HEAVY GUNS AT SEA.

By Commander William Dawson, R.N.

The last seven years have witnessed a marvellous revolution in the weight of the guns carried by H.M.'s ships, in the carriages upon which they are mounted, and in the appliances by which they are worked. Seven years ago, several of the ablest naval captains officially stated in their printed evidence before an Admiralty Committee, what was the general opinion of the whole Navy, that it was impossible to work guns over six tons weight on the broadsides of ships at sea. Yet at this moment 25-ton guns are being worked in a seaway on the broadside, with far greater ease and security than 25-cwt. guns were at that time. More remarkable still, the mechanical power is so increasingly applied, that the man-power essential to manœuvring heavy guns at sea, is in an inverse ratio to their weight. Thus, in an emergency, apart from the loading, four men can work the 25-ton, 18-ton, or 12-ton broadside gun at sea, by taking the several duties successively; whilst eight men can hardly manage the rope-worked 6½-ton gun; and under similar conditions of heel, 14 men have enough to do to jerk the 3½-ton 64 pounders about on truck carriages. This reduction of human labour is accompanied with a corresponding rapidity, ease, and regularity of movement, highly conducive to accuracy of fire and to safety; whilst it exposes far smaller bodies of men to the contingencies of war both on the battery and upper decks.

Ten years ago, when I ceased to be senior Lieutenant of the School of Gunnery at Devonport, the standard broadside guns were those of 58 cwt. and 65 cwt. worked on antiquated truck carriages by fourteen men. Those who have, in former days, worked the officers' gun at first quarters in the "Excellent," may remember the exhaustion incidental to the jerking action, both on the handspikes and on the tackles, in dragging the gun round the sweep piece to different bearings beyond the "wooding" point. On the "Cambridge's" broadside was a 95-cwt. gun on an equally barbarous rear-chock carriage, which 22 stalwart seamen, urged to their utmost powers, vainly strove to train with rapidity equal to that of the 65-cwt. guns, and after breaking most of the gear, the attempt had to be abandoned. The principal slide gun of that period was the 68-pounder of 95 cwt., a good shooter, most unsafely mounted. A single rope on either side, and a single whip in rear, formed the running-in gear. The carriage was not tied down to the slide, nor was the slide tied down to the deck. The compressors did not control the movements, except when set up for actual firing. And when the ship was in lively motion at sea, it was highly dangerous to cast off the lashings so as to use the gun. For, whilst in the fore and aft position, the gun might capsize or fetch way; and in the attempt to run it in, to shift the pivots or to load, there was a constant peril that in a quick roll it might break loose from all control. These slide guns, therefore, were seldom used in a seaway, and when they were, it was no small relief to all concerned when they were again firmly lashed to the decks and bulwarks. Captain Preedy's evidence, in 1865, as to similar slides for the 6½-ton guns in the "Hector," is applicable to both weapons: "the other day we had great difficulty in running the gun in with 22 "men on the train whips and tackles attached to the carriage, the ship "heeling over 6°; but the fact of firing the gun, I have no doubt, "would have brought it in. Why I alluded to running in was this, "the ports of these iron ships are low, and if you get a gun out and "cannot get it in again, it would be a serious matter in a sea-way, for "you would ship such heavy seas that it would become a very serious "matter." The present Rear-Admiral G. T. P. Hornby stated, in 1865, that Captain G. O. Willes, R.N., having cast loose for exercise in a sea-way, a 6¼-ton gun so mounted, the gun was unmanageable, and the men were afraid to go near it. Any experienced naval artillerist who will carry his thoughts back seven years, will wonder at the hardihood of Captain Willes in attempting, in a sea-way, to cast the lashings off the slide guns of that period. So unsafe were the gun slides then in use, that ships so provided were virtually disarmed by a moderate swell of the sea, as reported by the late Admiral Warden and the Captain of the "Lord Clyde," so late as 1866. Nor need we wonder at nor blame our talented military brethren for perpetuating such rude and antiquated truck carriages, and such unsafe gun-slides. Seamen and the Admiralty knew by sad daily experience the results, but soldiers and the War Office provided the appliances. Had our able military providers had a week's experience at sea with their own contrivances, they would no doubt have speedily devised a remedy; but they were dependent for information at second-hand from seamen who, though handling heavy ordnance every day of their lives, are technically supposed to be supremely ignorant of artillery, their carriages, and stores. It speaks well for their capacity, that the War Department which has no interest in the Navy, and their military subordinates who have no knowledge of its specialities, should have made so few bad guesses.

When, however, it was proposed to mount guns on ship-board over six tons weight, the problem of safety, facility, rapidity, and accuracy of motion in all directions and in all weathers, with perfect control of every movement, lateral, vertical, and longitudinal, was quite beyond the ordinary ken of seamen or soldiers, mechanics or engineers. So great a mechanical authority as Mr. H. D. P. Cunningham, R.N., stated in this Institution* in 1864, "it has often been remarked to me "by officers, that they always dreaded casting loose their 68-pounders "(95 cwt.) at sea, and were always delighted when the guns were "again secured. If, then, this anxiety existed in regard to guns of "between 4 and 5 tons in weight, how great must it be, or rather will "it be, when dealing with guns three times heavier, with probably all "the embarrassing accompaniments of wet, slippery decks. Can we "continue," he asks, "to work our heavy guns by manual power? " . . . Arms of flesh and bone must give way "to the iron arms and sinews of the mighty steam-engine." He pointed out that though 12-ton guns may be worked by 21 men on a level deck in smooth water, it was then, in 1864, doubtful to the best mechanicians if 30 men could control such ponderous weights at sea. Yet, seven years later, four men are found controlling with perfect ease and safety on the broadside at sea, a weapon which, with its slide, is nearly three times heavier than the 12-ton gun referred to, whilst Admiralty Minutes state that ordnance of 35-tons weight, or, including the carriage, about 50 tons in all, can be worked on the broadside with ease. These guns could be managed more safely, with less exertion, by fewer men than that now required for the 3½-ton guns on four truck carriages, and be moved with smooth, accurate, and rapid movements in all directions.

Turret carriages have undergone corresponding improvements. To minimize the vertical opening of the port, whilst obtaining adequate elevation and depression, gun and carriage and slide were bodily raised and lowered by screws acting separately or in pairs, under either end of the slide. Should the altered heel of the ship, or a change of object, demand a sudden movement from the highest elevation given by the port, to extreme depression for the delivery of a plunging fire through the decks of a ram, the moving slides of the turret ships "Wivern" and "Scorpion," would take, in smooth water on an even keel, one hour to alter the elevation of their 12½-ton guns; improvements introduced into the moving slides of the "Royal Sovereign" enables them to accomplish this change, in smooth water, in half-an-hour; alterations made in the moving slides of the "Prince Albert" enable extreme changes of elevation to be accomplished in 2½ minutes instead of 40 minutes. But the great change of all, has been to build the slides into the turrets as fixed strengthening struts or beams—in fact, doing away with slides altogether—and employing a compound pivoting carriage, in which the gun alone is lifted and lowered at its trunnions, and effecting extreme changes of elevation with 25-ton guns in the "Monarch" in less than four minutes. The importance of small vertical port area is evident in raising the lower cill higher above the water, limiting incursions of the sea, keeping out hostile bullets, and taking less strength out of the turret walls. The value of rapidity in making extreme changes of elevation will be evident to those who keep in view the manifold services of war ships. Take one recent example:—In September, 1870, a broadside ship, the "Royal Oak," engaged at shell practice, firing at targets 12-feet by 12-feet to represent gun-shields. These were marked on the Rock of Gibraltar, in Catalan Bay, at the heights of 400, 500, and 710 feet. The 8-inch 9-ton main-deck guns could not be fired at even the lowest target at a less distance than 1600 yards, as the marks could not be seen through the ports over the sights. But the upper deck guns could have been aimed right over the rock at that range. Now, if whilst bombarding a battery at such a moderate height as 400 feet, a hostile iron-clad had attempted to ram the "Royal Oak," her broadside guns could have been rapidly changed, in not more than a few seconds, at the last moment from the extreme elevation due to the lower battery, to the extreme depression demanded for plunging fire. But, with their guns on the bottom step to hit these high marks, the turret ships as originally fitted with moving slides, would have taken from 40 to 60 minutes to execute this simple evolution; and whilst it was being executed, those ships would have been unable to fire a shot. Now, considering the brief duration of the critical part of naval actions, and the value of heavy fire at the decisive moment, time must ever be a most important element in naval gunnery. Quickness is not, however, the only important object gained by the substitution of compound pivoting carriages, which do not touch the turret walls, and are not, therefore, affected by any hammering the armour may receive, for they rest upon girder beams below the decks, built into and imparting structural strength to the turret, in all the later ships.

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* See Application of Steam Power to the Working of Heavy Guns, by H. D. P. Cunningham, Esq., R.N.; Journal of the Royal United Service Institution, vol. viii, No. 30, 1864.

After dwelling on the difficulties which the designers of modern gun-carriages have had to overcome in imparting motion in so many directions to ponderous weights, on an unstable platform, and in controlling their movements when subjected not only to the rapid oscillations of the waves, but to the violent action of their own charges, one of the ablest scientific organs of civil engineers, the "Engineer," remarks, that the marvellous success which has been attained "constitutes one "of the most magnificent triumphs of mechanical engineering yet "seen, if we take into account the limited space and limited power "available;" and "this problem has not been solved by trained "mechanical engineers; on the contrary, so far as the British Navy is "concerned, it has been solved by a naval Officer, Captain R. A. E. "Scott, R.N.," the distinguished gunnery Officer who lately held the office of Admiralty "Superintendent of Gun-carriages." This opinion is endorsed by the most competent naval authority, the late Controller of the Navy, who wrote in an official Minute, dated 4th May, 1869, that "most important benefits have accrued to the Naval Service "through Captain Scott's exertions, and that, without those exertions, "neither 12- nor 20-ton guns would have been successfully worked on "the broadside of ships." To this I have only to add, that every heavy gun in the Navy, whether mounted in turrets, on turntables, or on broadsides, is partially or wholly mounted and worked on carriages, and with appliances devised by the same officer. Whilst the United States Government took a large sum in last year's estimates for the reconstruction of their 10-inch and 15-inch gun slides, our mechanical carriages and machinery are the admiration of the ablest civil engineers and naval Officers, and are being copied by all the maritime nations of the civilised world. When we recal what a vast and undreamt-of revolution has been wrought by this naval gunnery Officer within the last seven years, we must not be surprised that the present excellence was not all attained at once. Old prejudices had to be overcome, and officials had to learn that a seaman might know how to manage a gun at sea. Each step of progress represents a victory won, not only over a talented* competitive design, but often over an "improving" department, committee, or official.† Until the "piracy" or the "improvement" had utterly failed, the original design was not admitted; and, at one time, so high ran the departmental contention, that it was necessary for the Admiralty to interpose its authority, and order pattern-carriages to be made in a Royal dockyard under their own eye. As it is best to "let bygones be bygones," I refer to what the late Controller of the Navy calls "discouraging circumstances," not to illustrate the personal and professional difficulties which beset the Navy in acquiring the full use of a good invention, but to account for the ever-advancing mechanical progress noticeable year by year in our naval carriages, each advance representing not so much a novelty in design as a battle fought and a victory won; and also to account for the defects and deficiencies to which I shall have to refer in some details of the carriages still in use. What was written by the Controller in 1867 is true, though in a less degree, in 1872, viz., "that "if the plan of constructing carriages and slides proposed by Captain "Scott, in 1864, had been adopted, we should not, in 1867, be stating to "their Lordships that the service slides and carriages are too weak," and, after enumerating the several constructive details, the Controller adds "all these improvements might have been secured for our naval "artillery as early as 1865; but, unfortunately, the view taken by the "recognised department entrusted with this especial duty was opposed "to these plans."

Armaments of Ironclads.—Concentration of fire, that great dream of the most eminent naval artillerists, is now effected, not so much by converging a large number of light guns upon one point, as by concentrating the weight of numerous small guns into a few heavy ordnance, each capable of effecting, with one large projectile, a far greater shock than that hoped for from the simultaneous blows of many small shot. If such concentration was considered desirable in battering walls of wood or stone, it is much more essential in hammering walls of iron. But an idea prevails that the armament of a ship should consist of guns capable of penetrating her own sides, rather than those of hostile ships. Hence we find that the "Hercules," for instance, has very much less to fear from a fleet of iron-clad "Achilles," of 9,694 tons, than from a single unarmoured "Inconstant" of 5,782 tons; seeing that shot from the four 9-ton and twenty-two 6½-ton guns of the ironclad "Achilles" would, at 1,000 yards range, rebound off the sides of the "Hercules," whilst every shot from the ten 12½-ton guns of the unarmoured "Inconstant" would perforate her thick plated antagonist.

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* See Additional Particulars as to his Method of Working Heavy Guns, by H. D. P. Cunningham, Esq., R.N., Journal of the Royal United Service Institution, vol. x, No. 39, 1866.

† Modern Gun Carriages for Heavy Naval Ordnance, Journal of the Royal United Service Institution, vol. x, No. 41, 1866.

The influence which the introduction of machinery for working ordnance at sea has had upon the armament of ships may be understood by comparing the weight and power of the several guns carried before and after its adoption. The "Minotaur," the largest ship in the Navy, is also one of the worst armed. With twenty-two 6½-ton guns, mounted on slow-firing rope-worked carriages, she has only four 12¼-ton guns on mechanical slides available for heavy weather. Whilst her sister, "Northumberland," is enabled, by the use of quick-pointing machinery, to carry 68 tons more of artillery, and to work twenty-six heavy guns under all conditions of weather, having only two unsafe rope-worked carriages.

The "Warrior" now carries 10 tons of artillery more than before; yet her offensive power is concentrated in twenty, instead of twenty-eight guns. The "Warrior" can now work twelve guns with accuracy in a gale of wind, and has only eight, instead of twenty-four guns upon unsafe rope-worked mountings.

The "Prince Consort" now concentrates her 160 tons of artillery into fifteen pieces, every one of which can be safely worked in any weather, instead of dispersing it into twenty-four smaller pieces, twenty of which, having rope-worked mountings, were inaccurately worked at all times, and were useless in a sea-way.

The "Zealous" was sent to the Pacific before the value of machinery was appreciated, and is, consequently, the most helpless of our seaworthy ironclads. Her armament consists of twenty 6½-ton guns on rope-worked mountings, so that, in an encounter with a hostile unarmoured "Inconstant," carrying ten accurately moving 12½-ton guns on mechanical slides, the ironclad "Zealous" would be overmatched in moderate weather, and would, in a gale, be a helpless mark for her better armed, though unclad, antagonist.

The "Royal Alfred" carries, in proportion to tonnage, the heaviest armament of all our ironclads. But her eight 6½-ton guns are unsafely mounted on inaccurately rope-worked slides, and their offensive powers cannot be fully developed. The ten 12½-ton guns can be very efficiently fought by machinery, though they are not so thoroughly effective as the corresponding guns in the "Sultan," which ship has the best mounted artillery in the Navy.

The "Sultan," "Repulse," and "Prince Consort," are the only ships which, being exclusively furnished with mechanical slides, can freely use their whole armaments in any weather, and fully develop their

Broadside ironclads.	Weight in tons.	Heavy guns.			Gun carriages.		Complement of men, &c.	Reports of Captains, &c., on rope-worked gun-carriages in a sea-way.
		Number of pieces.	Total weight.	Tons weight of ship per ton of gun.	Worked by machinery.	Worked by ropes.		
	Tons.	No.	Tons.	Tons.	No.	No.	No.	
"Minotaur"	10,627	26	193	55	4	22	706	Training "tackles are insufficient altogether."
"Agincourt"	10,627	28	218	49	6	22	705	
"Northumberland"	10,584	28	261	40	26	2	705	
"Achilles"	9,694	26	179	54	4	22	705	"Cannot be worked satisfactorily" Scott's running-in chain "is much required." For chase-guns, mechanical training gear "is absolutely necessary."
"Sultan"	9,286	12	194	48	12	...	630	
"Warrior"	9,137	20	202	41	12	8	709	"Have not been controlled by traversing tackles, but have fetched way to leeward."
"Black Prince"	9,137	28	192	47	4	24	709	
"Hercules"	8,677	14	195	44	10	4	630	
"Lord Warden" and "Lord Clyde"	7,842	18	164	48	16	2	606	"In a sea-way they are faulty." "When there is only a slight rolling motion, it is difficult to keep the gun steady."
"Bellerophon"	7,551	13	145	48	10	3	545	"Scott's carriage and slide have been put to the severest tests, and in every trial have worked easily and well."
"Caledonia" and "Ocean"	6,832	24	166	41	4	20	615	
"Prince Consort"	6,832	15	160	43	15	...	605	"The present chains (Scott's running-in) are very efficient."
"Hector" and "Valiant"	6,713	18	122	55	2	16	600	"The compressors could not be depended upon, and the train whips carried away."
"Royal Alfred"	6.707	18	177	38	10	8	606	
"Swiftsure" and "Triumph"	6,633	14	139	44	10	4	450	
"Royal Oak"	6,366	24	166	38	4	20	606	
"Repulse"	6,190	12	108	57	12	...	—	
"Zealous"	6,096	20	130	49	...	20	511	
"Defence" and "Resistance"	6,070	16	109	55	2	14	460	
"Audacious" and "Invincible"	6,034	14	139	43	10	4	450	
"Iron Duke," and "Vanguard"								
"Penelope"	4,394	12	80	55	8	4	—	
"Hotspur"	4,010	3	32	125	1	2	190	
"Pallas"	3,787	8	50	76	4	4	252	"Unless great attention is paid to the traversing tackles, the gun is liable to fetch way, to the great danger of the gun's crew."
"Favorite"	3,232	10	59	55	...	10	271	
"Research"	1,741	4	26	67	...	4	150	The "indestructibility, power of control, training, elevating, and the smallness of its crew (9 instead of 19) is very manifest" in "Scott's carriage."
"Enterprise"	1,350	4	26	52	...	4	132	
"Waterwitch"	1,279	2	13	98	...	2	83	
"Viper" and "Vixen"	1,228	2	13	94	...	2	83	

whole offensive powers. Besides this superiority in mounting, the "Sultan" is the most powerfully-armed ship afloat. Carrying the same weight of artillery as the exceedingly well-armed "Hercules," and as the wretchedly-armed "Minotaur;" the "Sultan's" ordnance is concentrated into fewer pieces, viz., into eight 18-ton and four 12½-ton guns; and all these guns have high slides and low carriages, which lessen the shock upon the deck, and can be fought without pivot bars, should the side be indented and the pivot bolts bent by hostile shot.

The "Swiftsure" and "Audacious" classes do not fully possess these advantages for their ten 12½-ton guns, whilst each is disfigured by antiquated four-truck carriages for four 3¼-ton 64-pounders, which require more men to jerk them about inefficiently than are employed for the accurate and smooth working of the other four-times-heavier weapons.

Armaments of Unarmoured Ships.—In former times, for lack of concerted action between the artillerist and the architect, the Military Carriage Department and the Naval Constructors, the War Office and the Admiralty, the smaller classes of ships were first built, and then the armament was determined on. This led, in many flush-decked vessels, to strange contrivances for impeding the handling of ordnance.

Typical Unarmoured Ships.	Weight in tons.	Heavy Guns.			Gun Carriages.		Complement of men, &c.	Remarks.
		Number of pieces.	Total weight.	Tons weight of ship per ton of gun.	Worked by machinery.	Worked by ropes.		
	tons.	No.	tons.	tons.	No.	No.	No.	
"Inconstant" ..	5,782	16	164	35	10	6	605	
"Blonde" ..	5,696	26	155	37	2	24	600	Mechanical slides, 18 inches shorter than usual.
"Raleigh" ..	4,655	22	108	43	2	20	500	Do. Do.
"Ariadne" ..	4,583	26	97	42	—	26	540	Cannot fire a gun in a seaway.
"Volage" ..	3,078	8	46	67	—	8	300	
"Active" ..	3,078	10	52	59	—	10	300	Two common truck carriages.
"Scylla" ..	2,187	17	55	40	—	17	275	
"Blanche" ..	1,755	6	27	65	—	6	180	
"Dido" ..	1,755	8	33	53	—	8	180	
"Daphne" ..	1,574	4	20	78	—	4	180	A 64-pounder on truck carriage to be added.
"Cruiser" ..	1,045	5	20	52	—	5	177	
"Myrmidon"	877	2	10	87	—	2	101	
"Swallow" ..	774	3	10	77	—	3	100	
"Blazer" ..	254	1	18	14	1	—	—	Machinery for running in and out only.
"Banterer" ..	218	1	5	44	—	1	40	
"Staunch" ..	180	1	12½	14	1	—		Do. Do.

To a less extent this lack of concert is still observable in the mounting and working of artillery in certain of the smaller vessels. Not only is the weight of their guns out of all proportion to their tonnage, but they are squeezed into such confined spaces, that it is exceedingly difficult to use effectively even such weapons as they carry. A Captain, who was formerly a Gunnery Officer, and who was recently in command of such a vessel, writes that: "the fittings were of such an ante-" diluvian type that, unless you happen to be giving a lecture on fossil " armaments, I can hardly think that any allusion to her would be " acceptable."

There is only one unarmoured ship, the "Inconstant," with decent mountings for her guns, and even that vessel has not the best form of mechanical slides for her ten 12½-ton guns, and has six inefficient rope-worked slides. The "Blonde" and "Raleigh" will each have two complete 9-inch gun-slides, but they are to carry respectively 24 and 20 inaccurate rope-worked slides. We have not a single other gun efficiently mounted in unarmoured ships.

Small-Craft Armaments.—Several officers recently in command of sloops of war have told me that they found it exceedingly difficult to get the full value out of their armaments (some of which are described as miserably ineffective), in consequence of the inefficient contrivances for mounting and working them. One of these officers writes, "Our forecastle was too small for the slide to travel right round, " and necessitated its being shifted to three different rear bolts, or, in " other words, the practical impossibility of moving the gun from one " broadside to the other in the heat of an action. Moreover the ham-" mock netting and bulwarks which had to be cleared away for action " consisted of upwards of 100 separate pieces. As to there being any " real facilities for working the guns there were none."

The "Dido" class are 1,755 tons weight, and mount two 7-inch 6½-ton and six new 64-pounders of 64 cwt. This is one ton of artillery for every 53 tons weight of ship. The new 64-pounders are made six inches shorter than the converted ones specially to suit their narrow and encumbered decks. The pivot-bars of the 7-inch gun slides are also shortened in these vessels; and the guns are secured fore-and-aft amidships, side by side, between the mainmast and funnel casing.

The "Daphne" class are vessels of 1,574 tons weight, carrying two 6½-ton on slides and two 3½-ton guns on common truck carriages, or one ton of artillery for every 78 tons weight of ship. Their Officers state that those on truck carriages cannot keep pace with those on slides, and are consequently of small value. The slides are of the objectionable rope-worked pattern. By a very complicated and tedious arrangement both 6½-ton guns can be fought on the same broadside; but are then very inconveniently close to one another, and give the ship a heel of 6°, adding in a sea-way to the difficulties of safe, smooth, and rapid working. It is even said that the insecurity and difficulties of this rope-worked 7-inch gun slide, when the sea is in lively motion, are such as to have suggested the idea, not of improving the mechanical appliances, but of turning down two tons off the weight of the 6½-ton gun.

The lack of concerted action between the Military and the Naval Departments is very evident in the case of the new "Swallow" class. These are vessels of 774 tons carrying one 7-inch $6\frac{1}{2}$-ton, and two 40-pounders Armstrong breech-loaders, of 35 cwt., or one ton of artillery to every 77 tons weight of ship. The 40-pounders are not very useful weapons, and the real power of the armament centres in the 7-inch gun. When we remember that the "Stork" and other little 60 h.-p. gun-boats of about 250 tons carry a similar gun, and that the "Bustard," of 254 tons weight, carries a 10-inch 18-ton gun, the offensive powers of the "Swallow" will not appear very formidable. Yet, such is the lack of fore-and-aft space, that the 7-inch gun cannot be trained more than 30°, the slide then coming into contact with the main bitts. The bad expedient of shortening the pivot-bar cannot, in this case, be resorted to because of the wall-sidedness of the bulwarks. We have thus a weak armament, badly mounted, squeezed into a space so confined as to further limit its useful action. These various armaments are to be found amongst the most recent and most favourable specimens of our smaller vessels of war.

The 20-pounder Carriages.—A Captain recently promoted from a 5-gun vessel of 570 tons, writes:—"The armament consisted of one 64-pounder and four 20-pounders. The latter were mounted on low rear-chock carriages, so low that the captains of the guns had to lie down to see along the sights if the ship heeled over a few degrees towards the object." These little guns, which had been promoted from boat-service to the broadside of a ship-of-war, had no training gear, and were jumped about by hand-spikes when pointing, showing that the general rule obtains even with 13-cwt. guns that the smaller the gun, the worse the mounting.

The Four-truck Carriages.—Upper deck armaments often contain an admixture of 64-pounders of 71 cwt. This rifle is essentially a shell gun, and, though useless against the thinnest ironclad, may, if properly mounted, do good service against wooden ships and in bombardments. As it is, the 64-pounder has received an accession of 6 cwt. to its weight in the process of conversion from a 65-cwt. smooth-bore, and is still frequently mounted upon the primitive wooden truck, which is so well known for its jerky motions after the gun "woods," and for causing waste of brute force, and loss of time. Moreover, these rude carriages forbid correction being applied to the alteration of quadrature at different angles of training incidental to curved decks, which, by inclining the sights from the perpendicular, vitiates, beyond point blank range, both the elevation and the direction, and is absolutely fatal to accuracy.* It is highly discreditable to our artillery intelligence, that such primeval and inaccurate mountings should be applied to two rifled guns out of ten, in the "Active," (sister to the "Volage"); to two guns out of three in the "Hotspur;" and to the upper deck guns of our most recent ironclads.

The 64-pounder Gun-slides.—The "Volage" is an unarmoured ship of 3,078 tons, carrying two 64-pounders, 71 cwt., on old-fashioned slides, and six 7-inch 6½-ton guns on little less objectionable rope-worked slides. This ship carries, in all, 46 tons of artillery, or one ton of guns to every 67 tons weight of ship; whilst the "Royal Alfred" carries, in addition to her thick armour plating, one ton of artillery to every 38 tons weight of ship. Moreover, whilst most of the offensive powers of the "Royal Alfred" are developed by the use of accurately working mechanical gun carriages, those of the "Volage" are crippled by inefficient gun mounting, and the ship is absolutely inoffensive in a sea-way. The "Volage's," two 64-pounders on old-fashioned slides, with single ropes for running in, could not be used at all in a sea-way without great danger of crushing their crews, injuring the ship, or tumbling overboard. The cause of this will be evident when we remember that the power applied to run in a 64-pounder is multiplied but twice on the train whip, and not at all on the side tackles. Whereas, the machinery employed to run in and out a 12½-ton gun multiplies the manual power applied to two handles 59 times; and by very simple alterations of the mechanism, the running in and out gear of the 18-ton gun multiplies the manual power 80 times, and that of the 25-ton gun does so 120 times. The compressors of these mechanical carriages are so arranged as to aid the running-in gear in controlling the gun when moving in or out. But, even in moderate weather, the 64-pounders on slides, call for the united efforts of many men to run them in with a slight heel, and, whilst on their rollers for that purpose, are not controlled by compressors or other gear, and are apt "to take charge" altogether if the ship gives an unexpected roll. Their racers are not levelled up at either end to correct the influence of deck curvature on the sights when the gun is extreme trained; and the rough action of tackles is highly prejudicial to promptitude and nicety in imparting delicate touches to the aim. They are, therefore, the fruitful cause of much bad shooting in all weathers, of large unnecessary expenditure of ill-applied brute force, and of danger in a sea-way. These slides being as long as the new ones for the 12½-ton guns, narrow ships have these guns squeezed in anyhow and anywhere; whilst the new 64-pounders are made six inches shorter than the converted ones to get them into ships with small beam, and midship impediments. Surely the mechanical skill which can squeeze a 25-ton broadside gun into a space within six inches of its own length, and work it safely in all weathers with four men, could contrive that a 3½-ton gun might be mechanically worked, with as much accuracy, by as few men, and in similar weather, on slides of proportionate length.

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* See the Error of the Bow Gun, and other Errors incidental to the Practice of Great Guns at Sea, by Commander B. Sharpe, in Journal of the Royal United Service Institution, vol. vii, No. 26, 1863.

The 7-inch Gun Slides.—7-inch 6½-ton guns are mounted on rope-worked slides, which are raised on eccentric rollers for training by tackles, the elevation on and off the eccentrics necessarily disagreeing, and the alignment of the sights being liable to disturbance by the slide falling unevenly off its rollers. The running in and out gear is also of rope, worked by winches. The pivot bar bears the full force of the recoil unassisted by the racers, and an enemy's shot bulging in the ship's side, might jam the pivot and render the gun useless. The racers are not levelled for correction of deck curvature. Delicacy of touch in aiming is precluded by these clumsy contrivances; whilst safety in a sea-way is equally sacrificed. For lack of concerted action, the Military Carriage and the Naval Constructive Departments, contrive to make matters worse. The total length of slide is 12 feet, being within six inches of the length of those for the 12½-ton guns. Thus occupying more space than mechanical ones, they can only be squeezed into narrow ships like the "Volage" by shortening their pivot bars. But the coned rollers beneath the fore end are bevelled for 5 feet 1 inch radius, and they naturally refuse to revolve when this radius is thus trifled with. Even after this mutilation, the hatchways, skylights, and other midship impediments are found to impede the action of the rope winches. In the "Volage" class, the 7-inch guns, are, when not in use, secured fore and aft, in the middle of the deck, and right in the way of the principal working ropes. To get the guns into action from this position in a sea-way is a matter of some difficulty and danger; and, even in a moderate breeze, it has taken 20 minutes to get the weather guns on to their pivot bars. This delay in fine weather might have been avoided had the ship been designed to carry the guns on the fighting bolt, trained to an angle of about 20° or 30° with the fore and aft line.

Even when used for the bow and stern guns of such remarkably steady ships as the iron-clads "Hercules" and "Monarch," the rope-worked 7-inch gun slides were reported by their Captains to be inefficient. Whilst from more lively ships the official reports of their performances in a sea-way are most alarming, contrasting strangely with the safe and easy movements of guns two, three, and four times as heavy, worked by machinery. Thus, after a day's shooting in a gale, the late Admiral Warden reported that "two of the guns at different times got the better "of the crew, and banged in and out of the ports several times with "extreme violence, and two of the slides were to a certain extent "damaged by it. . . . . The result of that day's experience "would seem to prove that it is possible (though certainly never desirable) to cast loose and fire these 7-tons guns in a sea-way, either "singly or a few at a time, with well-trained men or experienced crews; "but under the circumstances of that afternoon, I add, that it would "have been utterly impossible to have gone to general quarters or "fought an enemy's ship."

Captain Roderick Dew, C.B., of the "Lord Clyde" reported:—"the rolls cause the guns to take charge, when the whole strain comes "on the fighting bolt or flap, resulting, as on one occasion, in the disabling of the slide."

Captain Connolly, of the "Pallas," reported, when working the 7-inch guns in a fore and aft position, "with much rolling motion, "unless great attention is paid to the traversing tackles, the gun is liable "to fetch way, to the great danger of the gun's crew between the gun "and the ship's side."

Captain Luard, of the "Hector," reported that "the compressors "could not be depended upon to control the guns, and the train whips "carried away."

Captain Vansittart, C.B., reported that "the heavy guns (6½ tons) "cannot be worked satisfactorily. . . . . For those capable of a "fore and aft or bow and quarter line of fire, mechanical training gear "is absolutely necessary."

Captain Boys, of the "Excellent," reported of the "Warrior's" 6½-ton guns that he "found on more than one occasion with ship rolling, "that guns trained before or abaft the beam have not been controlled "by traversing tackle with rollers eased up, but have fetched way to "leeward until they have been brought up by the ship's side."

Captain Goodenough, of the "Minotaur," reported that "tackles "are insufficient altogether."

Thus we have abundant official testimony that rope-worked gun-slides even for 3½- and 6½-ton guns are dangerous in every way; and that the ship so provided is utterly useless for purposes of war in a gale. Whilst, on the other hand, we have the clearest testimony from Captain Goodenough, Lord Gilford, and many others, that gun-slides can be worked by machinery with perfect safety in any weather. The Lords of the Admiralty themselves testified in a Board Minute, in 1869, that "in the 'Hercules' the 10-inch M. L. R. guns are worked with extra-"ordinary facility by the admirable machinery of Captain Scott, whose "improvements in gun carriages and their gear have been extensively "adopted in the Navy."

Rear-Admiral A. Cooper Key, C.B., F.R.S., when Director-General of Naval Ordnance, thus recorded his opinion of the comparative merits of machinery and of rope in working guns at sea:—"Owing to the "great improvement in gun-carriages, the 9-inch gun of 12½ tons has "a great advantage, in case of handling, over the 68-pounder of 4¾ tons, "being worked with few men, greater rapidity, *and far more security*."

The present Director-General of Naval Ordnance was one of six Officers who, in 1867, tested the carriages of the 12-ton guns of the "Royal Alfred" and "Bellerophon," and recommended the application of Scott's training gear, as "the one thing wanted is a thoroughly "efficient mode of training." They reported that, even in its then inefficient state, "with the present mechanical arrangements for working the "12-ton gun, we have no hesitation in saying that it is, in every "respect, worked as easily, if not more so, than the 6½-ton gun." Since that date, Captain Scott's plans have been adopted in their entirety in the "Sultan," &c., with vastly enhanced efficiency; but the old rope-worked carriages continue to militate against the full use of the 6½-ton and smaller guns.

Why on earth, then, that which answers so well with 18-ton guns should not be applied in a modified form to 6½-ton guns, passes my understanding.

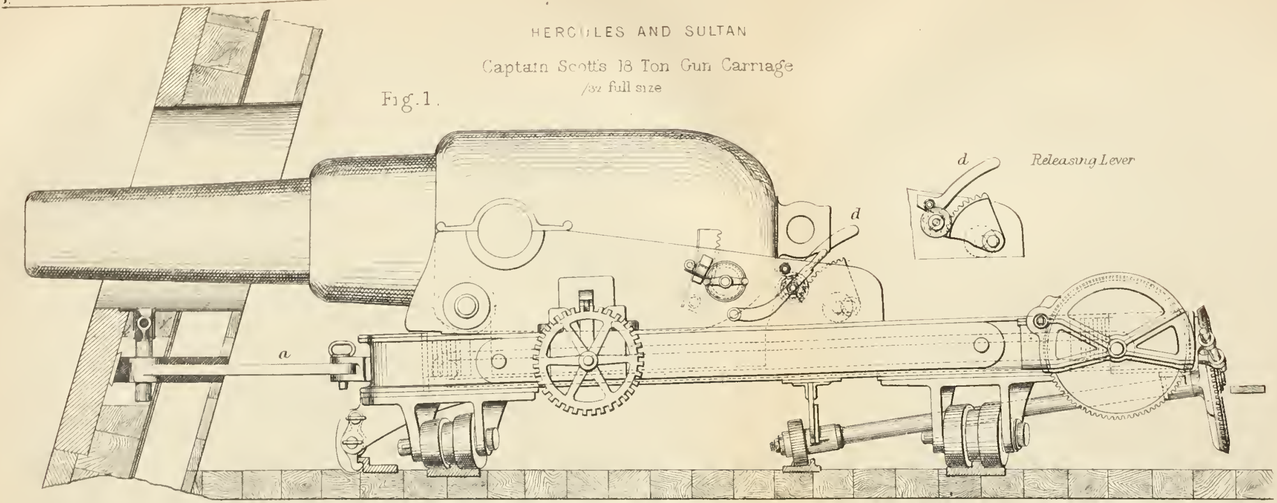
Mechanical Slides.—All guns of 9-tons weight and upwards are mounted on iron carriages and slides worked by mechanical appliances. Though the 8-inch and 9-inch gun slides are furnished with rollers and heavy racers, the main result of the recoil is received on a pivot-bolt in the port close behind the armour plating. A blow from a hostile shot bulging in that plate might easily jam the pivot bar and put a stop to all training. Years ago it was proposed to render the gun independent of distortions of the ship's side, by doing away with pivot bars and receiving the recoil on the racers as is now done in the 25-ton broadside gun. Years ago the high slide and low carriage was urged as a means of lessening the force of the recoil upon the slide and thence upon the deck. Had those and other suggestions been attended to at first, instead of at last, we should not now have so many incomplete carriages on hand. Those of the older pattern for 8-inch and 9-inch guns have several departmental piracies and so-called "improvements" of the original designs. These having failed to stand the test of prolonged experience at sea, are no longer being constructed, and the more recent ironclads have been provided with more perfect 9-inch carriages and slides. The 18-ton, 25-ton, and 35-ton guns appear to have been beyond the powers of "improvers," and their mountings have from the first been constructed on true principles, certain details being altered by the inventor as new and more simple mechanical powers, especially in the application of hydraulics, were devised. This, perhaps, explains why neither of the gunnery ships is provided with a single example of a complete mechanical gun-carriage and slide, or a model or picture or printed description of one. They have, for example, no means of giving instruction in working the brakes which are used to control guns of 9 tons weight and upwards in sea-going vessels. Heavy gun firing is conducted in their gunboats, from 9-inch gun slides having no training gear, but so fixed that the lateral direction is given by movements of the helm; and from 7-inch gun slides trained by tackles. Neither brakes, which hold the training gear when in motion at sea, nor traversing gear for moving the gun from port to port have been fitted in the "Excellent" herself; whilst the pauls for holding the gun when it is stationary are of an obsolete pattern, and seem to be used as if they were brakes. When accidents occur in sea-going ships from ignorance of mechanical apparatus, we must not blame those officers and seamen gunners who, having never previously seen or heard of them, remove, or grease, or otherwise render useless the controlling brakes. Still less should we blame machinery dealt with in such fashion by untrained men. The chapter on "Heavy Rifled Gun Exercise," in the "Manual of Gunnery for Her Majesty's Fleet," is based on the notion that 9-ton and 12½-ton guns are trained by tackles, the fact being that the cord which forms the trigger line is the nearest semblance of a rope which is, or at least ought to be, about them. What between the rare collection of obsolete and make-shift appliances in the "Excellent," and an imaginative handbook of gunnery, enquiries as to apparatus actually in use at sea are pursued under some difficulties. These sources of information as to the transition stage being within the reach of most naval men, I will confine myself to descriptions of the less "improved" upon, and therefore more perfect apparatus now being constructed.

More Complete Mechanical Gun Slides.—Much intelligent experience has been gained by Captain Lord Gilford, Gunnery Lieutenant Ingles, and the Officers and men of the "Hercules," of eight 18-ton broadside guns, fitted with the more complete apparatus. Lord Gilford wrote three years ago that, during a moderate gale, "the men worked the "guns with the same ease and confidence as if the ship was in dry "dock;" and again, six months later, after a heavy gale, "I believe

HERCULES AND SULTAN

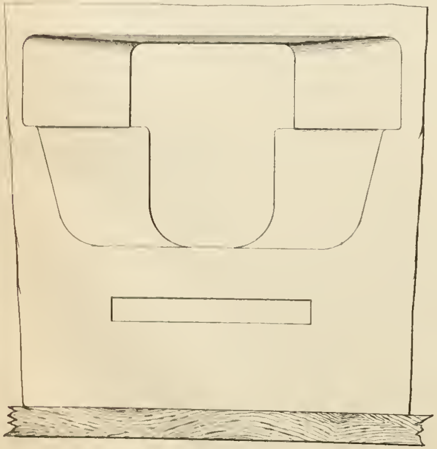
Captain Scott's 18 Ton Gun Carriage
1/32 full size

Fig. 1.



Elevation of Port (Sultan)
1/32 full size

Fig 4.



Captn Scott's Bow Compressor 18 Ton Gun
1/8 full size

Fig 2.

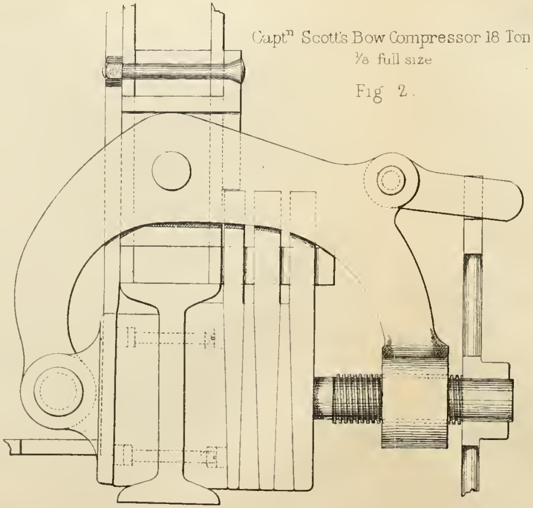
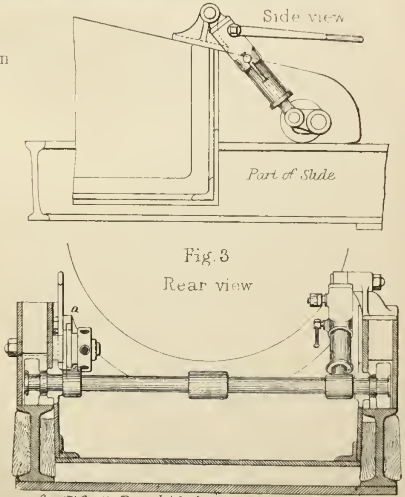
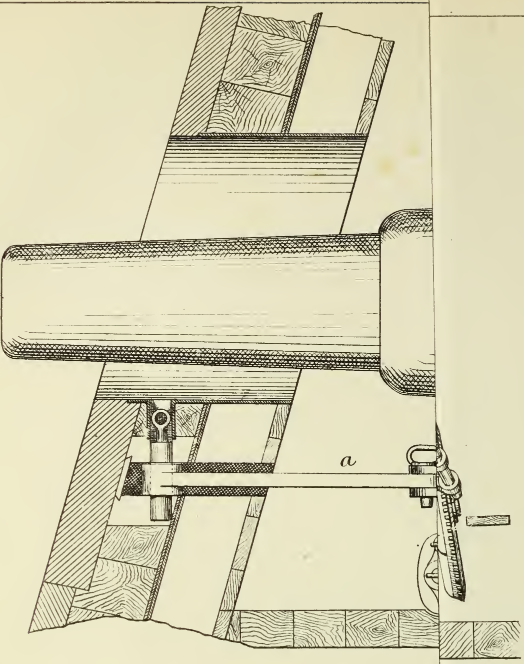


Fig. 3



Captn. Scotts Broadside Carriage for 18 Ton Gun.
Hydraulic Eccentric for lifting on rear Rollers

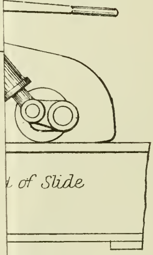
J Jobbins

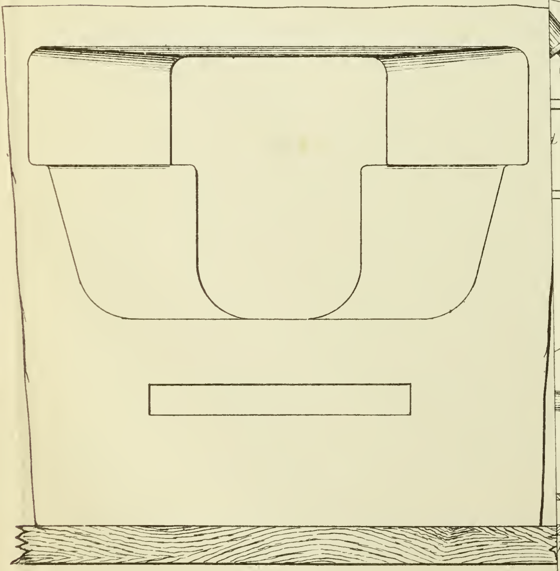


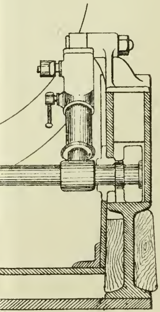
Elevation of Port (Sultan)
1/32 full size.

Fig. 4.

ide view





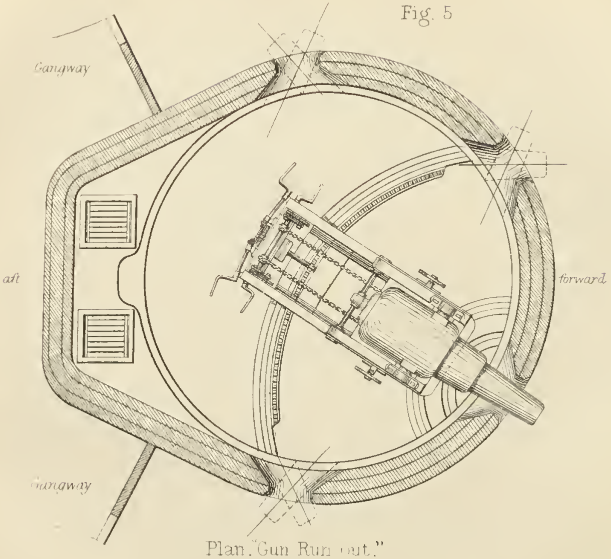


18 Ton Gun.
ear Rollers.

J. Jobbins

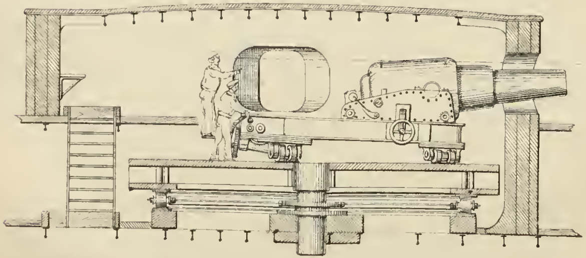
CAPTAIN SCOTT'S BROADSIDE 25 TON GUN CARRIAGE IN "HOTSPURS"
FIXED TURRET

Fig. 5



Plan. "Gun Run out."

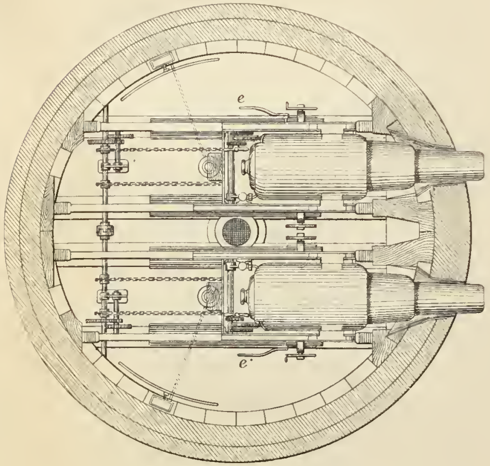
Fig 6.



Section through fixed Turret and moving Turn table
"Point".

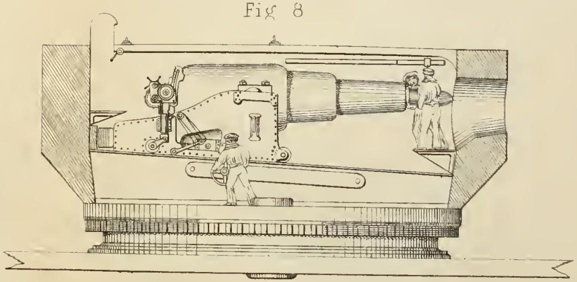
CAPTAIN SCOTT'S TURRET CARRIAGES & MACHINERY FOR WORKING
THE 35 TON GUNS IN H.M.Ss "DEVASTATION" & "THUNDERER"

Fig 7



Plan. "Guns Run out."

Fig 8



Section. "Load"

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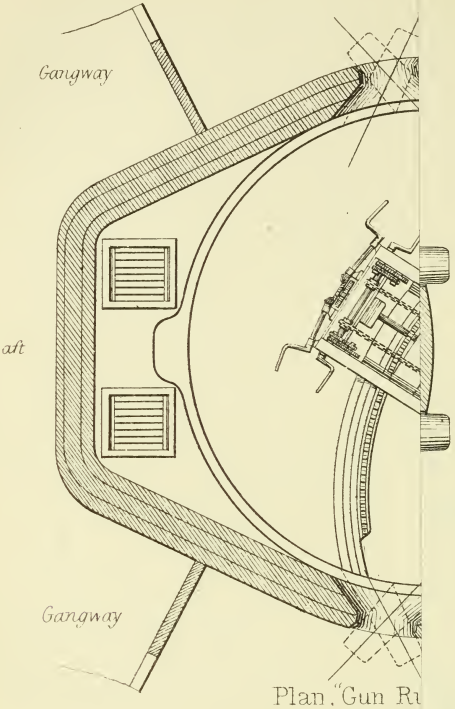
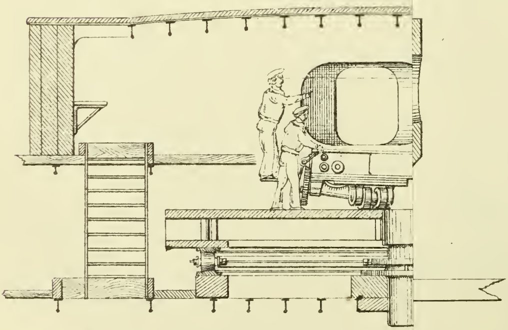
Pl. XV.

CAPTAIN SCOTT'S BROADSIDE 25 TONNG
FIXED TURRET



Plan, "Gun Ru
Fig. 6.



Section through fixed Turret a
"Point".

J. Jobbins

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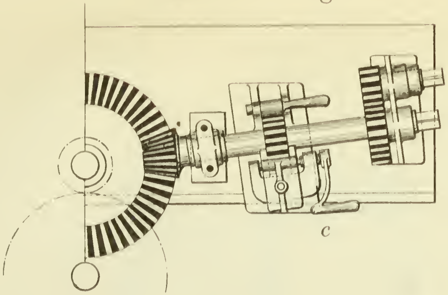
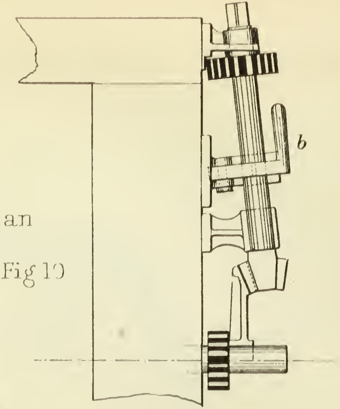
CAPTAIN SCOTT'S
25 TON GUN GEAR.
Scale-1/20 real size.

Rear Training Brake

Elevation Fig. 9.

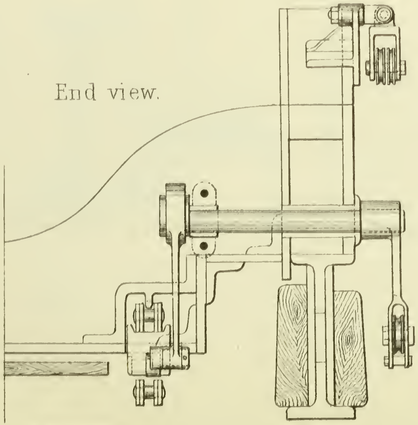




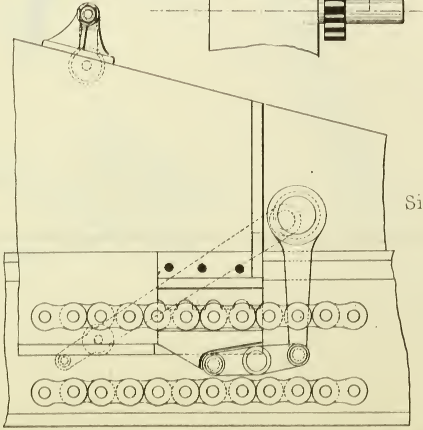
Plan

Fig 10

Chain
Nipping Gear
Fig. 11.



End view.



Side view

"the battery guns could have been worked, and the ship taken into "action at any time during the gale, using steam with full power." The "Sultan" is also fitted with eight 18-ton broadside guns, so mounted.

The leading principles observable in the complete mechanical carriages are great constructive strength; powerful moving machinery, so contrived as to be unaffected by the concussion of firing; self-acting controlling gear, almost independent of human carelessness; the gradual absorption of, rather than rigid resistance to, shocks; the dispersion of concussions over large surfaces; independence of distortion of or other injuries to the ship's side; smoothness and ease of motion in every direction, and safety under all conditions of the sea.

The most obvious specialities of these perfected mountings are:—

1st. (Plate XIV, fig. 1.)—Long, low, mixed cast and wrought iron carriages, on short, high, girder iron slides. The low carriage remedies the rearing back tendency of short high ones, and the consequent downward strain on the slide and deck. The height of the 10-inch gun slides at the centre of the trunnions is 2 ft. 2 in., and that of the carriage 1 ft. 11 in., making 4 ft. 1 in. in all, on board the "Hercules." The ports of the "Sultan" require the roller lugs of the 10-inch gun slides to be 3½ inches higher. The heights of 9-inch carriages and slides are similarly proportioned. The complete 9-inch gun slides, are found only in the "Sultan," "Blonde," and "Raleigh." They have no head-plate in front, and being thus made 18 inches shorter, they allow the gun to run further out, and occupy 18 inches less space. The pointing is also improved, and the length for recoil remains as before. Whilst maintaining the same height of trunnion above the deck when run out (viz., 3 feet 8 inches), the new carriage is 1 foot 8 inches high, or 11½ inches lower than the older pattern, the slide being raised to the like extent. The small space occupied by these short mountings diminishes the extent of armoured cover, and this again reduces the tonnage of the ship, and enables a handier vessel of lighter draft to carry protected guns of equal weight. Thus, the total length of the new slides, for 12½-ton guns, is 12 ft. 6 in., and of those for 18-ton guns is 15 feet; the total length of their carriages being respectively 6 feet, and 8 ft. 7 in., affording a recoil of 6 feet.

(Plate XV, fig. 5.)—The 25-ton broadside gun of the "Hotspur" is mounted on a slide only 15 ft. 6 in. long by 6 ft. wide, the carriage being 8 ft. 9 in. long. The axis of the gun is 5 ft. 1½ in. from the deck, the top of the carriage being 2 ft. 3 in., and the top of the slide 2 ft. 10½ in. in height. Being so near the water, the ports only provide for 2½° depression on the beam, and 1° right ahead, with 11° elevation. Each beam port gives an arc of 68° training, 44½° aft being abaft the beam. Each bow port gives training from 1° inside the line of keel to within 22° of the beam, thus overlapping the arc of the beam port. The turntable is used to change the gun from port to port; the training gear for moving it laterally when there. There is an arc of 91° round the stern, undefended, except by a couple of 64-pounders mounted on wretched four-truck carriages, which require between them seven times the number of men that it takes to train the 25-ton gun under the same conditions of sea.

2nd. (Plate XIV, fig. 1.)—The slides rest permanently upon their four coned-and-grooved rollers, on heavy solid metal racers, which brace and strengthen the beams and decks beneath, and are raised at the ends, so that the sights may not be affected by the curve of the decks.

3rd. (Fig. 1.)—The recoil is received from the grooved rollers by metal ribs cast on the upper face of the deck racers, and from a strong metal hook which ties the fore part of the slide down to the strong projecting lip of the front racer. There is also a single pivot bar (*a*), with movable pivot bolts in the slide and in the port behind the armour plating; but this is not essential to security, and the bar can be disconnected from the slide or from the port if necessary. The pivot bar is, indeed, omitted from the slide of the 25-ton broadside gun mounted on the "Hotspur's" turn-table, Fig. 6, pl. II, and though less in the way of loading than the V-shaped pivot bar, it might be dispensed with in lighter guns advantageously.

4th. (Plate XIV, fig. 2.)—The self-acting bow compressors consist of strong iron bows hung by their centres through a hole in each side bracket. From the carriage, short wedge-shaped plates are suspended between hard wooden baulks and wedge-shaped iron bars fixed to the girders of the slide. The weight of the gun when let down off its carriage-rollers drives the upper wedges tight between the lower ones, and the downward concussion of firing tends to press them still further home; whilst the action of lifting the carriage on its rollers, to run the gun in or out, relieves the wedges. A screw at the outer end of each bow, turned by a wheel, Fig. 1, sets each compressor hand-taught. The circumference of each wheel is provided with notches which are held by a paul. In practice, the pauls of both compressors may be permanently set to a given notch, or that on one side may be so fixed, and the other used to control the gun in running in or out. Firing battering charges of "brutal" R.L.G. powder and shell from the "Hotspur's" 25-ton broadside gun at sea, Fig. 6, pl. II, one man to each compressor, hove them so taught, that the recoil did not exceed three feet, and it became necessary to slacken the wheels five notches of the paul, to allow sufficient recoil for reloading. Once rightly adjusted, neither compressor was touched when moving the gun in or out.

5th. (Plates XIV, and XVI.)—Fig. 1. The mechanical training-gear consists of a crown wheel and bevel pinions driven by winch handles, which turn a shaft beneath the slide, armed with a cog-wheel working into a cog racer in the deck. A second driving pinion is provided, Fig. 9, giving twice-and-a-half more power, for use when the gun is so extreme trained that only one winch-handle can be worked, or in rolling, or at any time when extra mechanical power is needed. A paul, Fig. 10, *b*, is provided to be kept down when the gun is stationary, and a controlling brake, Fig. 9, *c*, for use when the gun is in motion. The brake consists of a diminutive bow compressor applied to the training gear near the winch handle. The object being to prevent the cog-wheel and shaft revolving, it is evident that brake power applied near the winch-handle gains all the advantage of the power given by the multiplying gear, in addition to its own frictional surfaces.

The power gained in training 6½-ton guns by the usual tackles is, at most, only three times the manual effort applied. Moreover, the loss of time in taughtening the tackle, and before the force of several men can be united in one combined pull; and the loss of space by stretching of the rope, makes it an exceedingly rough and unready mode of attempting to impart refined motions to heavy artillery. Whereas the manual power applied on two handles to mechanical training gear is multiplied 37 times in the case of 12½-ton guns, 52 times in the 18-ton guns, and 90 times in the 25-ton guns. Whenever greater training force is needed, the handles can be readily attached to the additional pinion Fig. 9, which multiplies these mechanical powers two-and-a-half times. Thus, the force exerted by one man on each handle in training a 12½-ton gun, becomes, by the use of machinery, equivalent to that of 92 men relying exclusively on brute force; and to that of 130 men in training an 18-ton gun; whilst two men do the work of 225 men in the case of the 25-ton gun. Moreover, the machinery can be applied with great promptitude and exactitude, contributing greatly to the rapidity of pointing at moving objects, or with quick helm movements.

6th. Where a turn-table is not employed under the rear of the slide to turn a foremost or after gun from a broadside to a bow or stern-port, and *vice versâ*, traversing apparatus is added to the training gear, Fig. 1. For this purpose, the training shaft is prolonged, and an additional cog-wheel works in a cog racer under the fore end of the slide, suitable means being provided for throwing the training gear out and the traversing gear into gear, and *vice versâ*, when needed.

Traversing turn-tables are fitted to transport fore or aftermost broadside guns to and from the bow or stern-ports, to 18-ton guns in the "Hercules" and "Sultan," and to 12½-ton guns in the "Sultan," "Lord Clyde," "Lord Warden," "Blonde," and "Raleigh."

7th. (Plates XV and XVI.)—For the longitudinal motion of the carriage upon the slide, running in-and-out gear is fitted. This consists of spur wheels and pinions worked by winch handles, which drive a shaft placed across the rear part of the slide, Fig. 5. Two endless chains run round sprocket-wheels on this shaft and on the fore part of the slide. When out of action the chains are not attached to the carriage, but, when needed, nipping eccentrics in the carriage, Fig. 11, being worked by a lever, catch the chains in their teeth.

8th. (Plate XIV, figs. 1—3.)—For running in or out, the carriage is lifted upon rollers by means of rear eccentrics, which are worked by an hydraulic on one side; or by notched arcs, near the other bracket, acted upon by pointed handspikes temporarily placed in sockets either in the eccentric shaft or in a drum attached to it. Pauls are provided for holding the eccentrics when the carriage is on the rollers. Buffer blocks are fitted to the fore part of the slide to receive the carriage in running out, in case, through inattention, it is carelessly permitted to strike heavily against the slide, and thus dislodge the projectile and charge from their seat. This carelessness should, however, be averted by a careful explanation to the crew of the evil consequences resulting from it.

9th. (Plate XIV, fig. 1.)—Complaints are occasionally made against the elevating gear which was adopted instead of Captain Scott's, but, on the whole, it seems to answer very fairly. It consists of a notched arc attached to the gun, acted upon by a cogged wheel and drum connected with the carriage. The periphery of the drum is pierced with sockets, into which pointed handspikes are temporarily placed, a clamp nipping the drum when the desired elevation is attained. A holding pin to take the sockets has been recently added to help the nipping clamp.

Royal Carriage Department.—It is due to the Director-General of Artillery and to the Royal Carriage Department to say that the workmanship displayed in these mechanical gun-carriages is of the highest order, and reflects great credit upon the manufacturing skill of the Royal Arsenal. This is so, not only in that which calls for most careful and skilful manufacture, but, so far as they afford opportunities for it, in the more primitive mountings, which stand condemned. The Navy does not and cannot find fault with the workmanship of any of its gunnery tools. It is exclusively to the form and design of some of them that we trace their failure to comply with the demands of naval warfare. When a mechanician, who is also a sailor and a gunner, supplies proper designs, the Royal Carriage Department possesses all the manufacturing skill requisite to embody those designs in most efficient forms. Let seamen gunners and mechanics agree upon such modifications of the heavier gun mountings as are needful to ensure accuracy of fire and safety of movement for the lighter guns, and the Royal Carriage Department is as fully competent to construct carriages for these latter guns, as they have shown themselves able to do so for 18-, 25-, and 35-ton guns.

Non-traversing Carriages.—The 9-inch guns of the 180-ton, "Staunch" class of gun-boats, and the 10-inch gun of the 254-ton, "Bustard" class, are mounted on slides similar to those already described, Fig. 1, excepting that they have no rollers and no training or traversing gear. They stand at the bows in line with the keel upon their two iron girders or chocks, a pivot bolt passing through each. In this fixed position, with the muzzle forwards, the object is brought on with the sights by the helm, thus involving alterations in the course of the vessel, and necessitating a constant advance in a direct line with the enemy. On occasions, the slide might be dragged round by main force to any fixed angle not exceeding 20° from the line of keel. What such vessels would do in narrow waters, or in a strong tideway, or in any case when the enemy was not standing still or running away, it is difficult to understand. There seems to be no adequate reason for withholding training gear, or for so limiting the angle of training. Every practical naval artillerist is aware that the compound motion imparted by combined rolling and pitching calls for promptitude and nicety of touch in training which the helm cannot possibly give; and that to attain equal accuracy from fixed guns, there must be very long and patient watching for chance shots, involving great loss of time. This wilful crippling of the power of the guns passes ordinary comprehension.

The 20-pr. Depression Carriages.—Though, in my opinion, the best way to encounter a torpedo vessel is with her own weapon, a very useful auxiliary defence is provided in 20-pr. breech-loaders, mounted, upon special depression carriages, which give a plunging fire from the upper decks. The surface of the iron slide is sloped to the front to an angle of 10°, and it is furnished with an hydraulic compressor. The carriage is of iron, and an elevating arc affixed to the gun, and worked with a pinion and wheel, instead of the drum and handspikes used with heavy guns, admits of 20° elevation and 30° depression. But the shortness of the gun, and the thickness of the ship's side, reduce the depression to 25° in vessels of the "Vanguard" class. Thus, with the ship on an even keel, projectiles can be thrown 100 feet high at 100 yards distance, or into a boat as near as 13 yards from the ship's side. For some unaccountable cause these slides have no mechanical training gear, so that they cannot follow the object laterally with ease or rapidity.

Capabilities of Ports. (Plate XIV, fig. 4.)—The importance which attaches to plunging fire, when the ram fails to take effect, is obvious, and it is satisfactory to find that in recent broadside ships it has not been lost sight of. Thus the "Vanguard" class can depress the upper battery guns 8°, and, when on an even keel, strike the water 43 yards off, whilst the main-deck battery guns can be depressed 6½°, hitting the water 37 yards off. The elevation varies from 9½° to 10½°, and the arcs of training of beam-ports are about 66°. Objection has been made to reducing the dimensions of ports, that it limits the field of view, and may give rise, in a general action, to guns being accidentally aimed at friendly vessels. On the other hand, large ports weaken the side, and expose both guns and gunners to hostile fire. To meet these difficulties, the "Sultan's" ports have been designed with their lower portions exactly corresponding to the space filled by the lower half of the guns in extreme training, and the upper portions enlarged laterally to give full arcs of view. Their width is 2 ft. 11 in. in the sight area above, and 2 ft. 8 in. in the lower portion, giving 70° of training, 10° of elevation, and 5° of depression. The main-deck portcills are 11 ft. 1 in., and the trunnions 12 ft. 7 in., above the water-line. To still further limit the incursions of the sea and of hostile shot, various plans of muzzle-pivoting have been proposed, but the plan which has found most favour is the compound pivoting system adopted for turret ships. No steps have, however, yet been officially taken for applying the compound pivoting system to broadside ships.

Turret v. *Broadside Guns.*—Whereas in many of the smaller classes of broadside ships the artillerist has just cause of complaint that the one object for which ships of war are intended is too often forgotten in their construction or equipment; in H.M.'s turret vessels every other consideration is sacrificed to what few guns are carried. The chief advantage which the turret gives to the artillerist is a large training arc to a few heavy guns. On the other hand, when aiming considerably before or abaft the beam, the intervention of the deck seriously diminishes the capability of delivering a plunging fire even when on an even keel, whilst it precludes it altogether with a degree or two of heel. This loss of depression cancels a portion of the advantage gained by the larger arc of training. Thus, whilst the

"Monarch's" after-turret gives an average arc of training of 173°, including dead points obstructed by rigging, &c., the "Hercules'" broadside guns give only about 66° without changing ports. But if the ship heeled from ½° to 2° from the object, the "Monarch's" guns could not, on extreme bearings, be laid horizontal, and would therefore be useless, and, even when the ship is upright, the after-turret guns could not, when trained aft, strike the water at a less distance than 550 yards. Whereas, at all points of bearing, the "Hercules" could depress the guns if the ship heeled 7° from the object, and, on an even keel, could strike the water so near as 40 yards.

Position of "Monarch's" turret guns.	Angle of Training.	Angle of depression deck admits of on even keel.	Nearest point of water struck on even keel.
			Yards
After turret, trained abeam.......	0°	7°	40
,, ,, ,, aft..........	95°	½°	550
,, ,, ,, forward......	78°	2°	110
Fore turret, trained abeam........	0°	7°	40
,, ,, ,, aft...........	74°	2°	110
,, ,, ,, forward.......	78°	1½°	180

Again, our ablest artillerists hold that there is no sufficient cause why armour-clad broadside ships should not also carry additional unprotected guns quite as well as unarmoured vessels. Their offensive powers might thus be enhanced in bombardments, in distant firing, and in many of the lesser operations of naval war; whilst in pitched battles, with other ironclads, the crews could, if necessary, be temporarily withdrawn under cover from the unprotected guns, and the ships be no worse off than if they did not possess such additional weapons. Now, as to the whole line of the broadside this is quite impossible in one of HM.'s turret vessels, though she may carry a few auxiliary guns for end-on fire at the extremities. Moreover, the turret, as usually applied, curtails many of the purposes to which ships of war may be applied, as wholesome continuous abodes for large numbers of men, and for carrying troops in emergency, as well as impeding their convenient handling. Great as is the advantage of this increased arc of training to the artillerist, yet, viewing the ship simply as a mere multiple gun-carriage, it is questionable whether a "Devastation," with eight covered broadside 35-ton guns, and a number of lighter unprotected ones, would not compete successfully with the "Devastation," as she is to be, limited to two double turrets.

Of the turret ships, the armament of the coast defence vessels of the "Cyclops" class bears the heaviest proportion to the tonnage, and that of the "Rupert" bears the smallest ratio. The "Fury" will be the largest turret ship afloat. She will weigh 10,464 tons, or only 120 tons less than the broadside ironclad "Northumberland." Her armament will consist of four 35-ton guns, giving a total of 140 tons of artillery. This is not much more than half that of the 28 guns of "Northumberland." Setting aside the question of longevity of heavy guns as effected by the "Woolwich" rifling, the "Fury's" armament would be unquestionably more formidable against a sister ship than that of the "Northumberland," or indeed than that of any other vessel afloat. But, as 35-ton guns can be quite as efficiently worked on the broadside, it is open to question whether a broadside ship of similar tonnage might not be so armed as to be equally effective against the "Fury," and far more effective for most of the numerous contingencies of naval war. The turret is, however, an existing method of mounting guns at sea, deserving our close attention.

Turret Ironclads.	Weight in tons.	Heavy Guns.			Gun Carriages.		Complement of men, &c.	Remarks.
		Number of pieces.	Total we	Tons weight of ship per ton of gun.	Worked by machinery.	Worked by ropes.		
	tons.	No.	tons.	tons.	No.	No.	No.	
"Fury"	10,464	4	140	75	4	—	300	Scott's compound pivoting carriages.
"Devastation" and "Thunderer"	9,188	4	140	65	4	—	250	Do. Do.
"Monarch"	8,322	7	131	63	6	1	525	Do. Do.
"Rupert"	5,284	4	43	123	2	2	200	Do. Do.
"Royal Sovereign"	5,080	5	62	82	5	—	—	Lifting slides.
"Glatton"	4,840	2	50	97	2	—	200	Scott's compound pivoting carriages.
"Prince Albert" .	3,905	4	50	78	4	—	—	Lifting slides.
"Cyclops," "Gorgon," "Hecate," and "Hydra" ..	3,336	4	72	46	4	—	150	Scott's compound pivoting carriages.
"Scorpion" and "Wivern"	2,751	4	50	55	4	—	155	Lifting slides.

Turret-gun-carriages. (Plate XV.)—The "Glatton" is the latest addition to our 25-ton gun turret ships, and contains some improvements in gun-mounting, partly suggested by the experience of hydraulics gained in the "Monarch." The substitution of hydraulics for levers has been delayed by the necessity of gaining experience as to those in use at sea. A quick working double action hydraulic jack, Fig. 3, has now been devised by Messrs. Tangye for universal application in lieu of levers, which is now being substituted to lift 18-, 25-, and 35-ton gun carriages upon their eccentric rollers for running in or out. These carriages can now be easily raised on their rollers by one man. The "Glatton" is 4840 tons weight, and mounts two 25-ton guns in one turret, or one ton of artillery to every 97 tons weight of ship. Four girder beams are built into the turret below the deck, Fig. 8, constituting strengthening struts, and forming a part of the ship, which might with advantage be decked.

These fixed girders form slides on which are placed two compound pivoting gun-carriages, the training being effected by revolutions of the turret itself. The only point of principle in which the turret carriages differ from the broadside ones, is in their possessing compound vertical pivoting gear, to minimize the open area of the port. The aim is effected by sights on the top of the turret on which allowance is made for the difference of height above the gun. Inaccuracies in the parallelism of the sights and axis, are so far compensated by the greater distance between the front and rear turret sight, that, with rolling motion, better shooting is sometimes made than with the short radius sights on the gun itself. As already stated, the small port aperture was originally met by lifting bodily the gun-carriage and slide, to set heights or steps by means of four vertical screws acting irregularly beneath, an operation taking about an hour in smooth water, and scarcely possible in a sea-way. It is now met by raising the gun only. This is effected by supporting the gun on wrought iron trunnion blocks, susceptible of vertical motion in the carriage brackets. These blocks are united by a curved transom, acted upon beneath its centre by the ram of an hydraulic jack, Fig. 7, *e*, attached to the carriage, which raises the gun bodily about six inches per minute. Iron props of different lengths are used to support the trunnion blocks in the different positions in which it is intended to fire. On each step elevation or depression is regulated, as usual, by elevating gear, Fig. 8, which must necessarily differ from that attached to broadside guns, in that it has to be adapted for use with the axis at the three different heights. A single man moving a small wheel at the cascable of the gun, works the pinion and spur-wheel, which raise and lower the breech along the notched elevating bar. In the "Monarch" the steps are so arranged that the upper one gives no elevation, but 7° degrees depression; the bottom one no depression, but 15° elevation; and the middle step, which would be the ordinary fighting one, gives 9° elevation and 2° depression. This division of steps could be altered at any time by substituting iron props of other heights.

The carriages are adapted to the circular shape of the turret, by lengthening the inner bracket of each, and both carriages are so reduced in front of the trunnions as to leave a considerable interval between them and the turret walls; so that the carriages may not be affected by concussions and indentations received by the armour from hostile fire. The shocks sustained by the trunnion blocks are diffused over large bracket surfaces by the wrought-iron guides in which they move. The shocks imparted to the carriage are conveyed to the girders beneath through very long brackets, the cast-iron interiors of which, resting upon the wrought-iron girders form excellent friction surfaces.

35-*ton Turret Guns.* (Plate XV.)—The carriages for the 35-ton guns in the "Devastation's" turrets, differ but slightly from those for 25-ton guns in the "Glatton," and for 18-ton guns in coast defence ships. The hydraulics for lifting the 35-ton guns from step to step at the trunnions are fixed in the floor of the turret, Fig. 7, instead of to the bottom plate of the carriage as in the 25-ton and 18-ton guns. This necessitates the provision of two sets of lifting hydraulics, one for use when the gun is out, the other when it is in.

Running in Turret Guns, Fig. 7.—The power employed for running in and out the 35-ton gun is multiplied in the ratio of 280 to 1, and is applied on four handles; whereas the gear used with the "Glatton's" 25-ton turret gun multiplies the power applied to three handles 210 times; and, with the "Monarch's" 25-ton guns, 114 times on three handles. The necessity for providing increased mechanical power for running in turret guns, as compared with broadside ones, appears not to have been fully anticipated, nor is the cause very obvious, aside from moral considerations. It appears, however, that the power applied to run in and out the 25-ton broadside gun in the "Hotspur," Fig. 5, multiplies 120 times on two handles, whilst that applied to the 25-ton turret gun in "Glatton," multiplies 210 times on three handles. The same increase is observable as to the 18-ton gun. The broadside ones being run in and out by gear, multiplying 80 times on two handles; whilst the gear of the "Cerberus" class of colonial turret ships multiplies 109 times, and that of the later turret vessels multiplies 150 times on three handles. Thus, nearly twice as great mechanical power is required to run guns in and out when placed in turrets, than when mounted on the broadside.

Working Turrets.—The enormous weight of turret is turned upon coned rollers, by machinery worked by steam or by hand-power. The handles by which the latter is applied are placed on the deck outside its periphery, where the winches for running in are also placed. The "Monarch's" turrets perform half a revolution in 18 seconds when worked by steam, but take 80 seconds to do so when moved by the manual labour of 18 men. The men who control the revolutions are in the latter case out of sight of the director of the turret, and cannot observe what they are doing, nor see the motions of their director; they have, therefore, to act in blind obedience to his voice, by the inflections of which alone they can guess the urgency or the amount of motion required. Those delicate touches of training which a smart captain of a broadside gun can promptly secure by the impatient wave of his hand, cannot be so carefully given by the turret in blind obedience to the voice. Moreover, the man who aims is not the man who fires, and the main body of the turret crew are hid from the view of both, and isolated from those men who load and tend the gun. This separation can hardly recommend itself to the experience of officers who have been much under fire, and who know the value of keeping in full view every man who is working those guns on which victory depends. The average British seaman is, under trying circumstances, but flesh and blood, deriving moral support from the presence of his comrades, and stimulated by the personal observation of his superiors. To be poked away in small squads, separated in dark boxes, idly listening to the roar of an unseen battle, with little to do but think whether each concussion felt arises from a projectile opening a sluice gate for the sea, or from a ram in the act of running over their vessel, or from a torpedo projecting it piece-meal into the air, is not a condition of existence favourable to calm exertion or to great courage. The moral aspect of the service turret system is apt to be overlooked in "piping times of peace," but it will not be forgotten by officers who have had much experience under fire.

Artillery Training afloat—It is obvious that with mechanical gun carriages skilled labour should not be, as formerly, confined to a few principal operators, but ought to be available from every man attached to the gun. To enable this skill to be acquired, all the obsolete mountings should be removed from the boys' training ships, from the Naval Reserve drill ships, and from the gunnery instruction ships, and boys and men should be trained to the use of existing appliances. By early and continuous practice with machinery, even young lads acquire great delicacy of touch and facility of execution. But working men, who thus learn chiefly through their hands and eyes, cannot be taught the use of mechanical apparatus without seeing or handling it. Moreover, in proportion as artillery increases in size and is reduced in number, eye-training acquires greater importance, and should occupy a foremost position in physical gunnery. Rapidity and correctness in ascertaining and communicating the ever-varying distance should occupy a prominent place in the preparation for battle. The influence which the sighting of guns has upon the aim when shooting with lively motion should be carefully observed, with a view to the diminution of unavoidable visual errors. Each Palliser shot from a 12-inch 25-ton gun with a battering charge, costs £6 3*s.* 5*d.*, and from an 18-ton gun costs £4 9*s.*, and from a 12½-ton gun costs £3 2*s.* 6*d.*; and from a 9-ton gun, costs £2 6*s.* 7*d.*; and from a 6½-ton gun, costs £1 12*s.* 2*d.* Whilst each discharge of Palliser shell is yet more costly, and that of common shell a trifle less. It seems reasonable then to expect that every pains should be taken to ascertain what is the exact distance of the target at which such costly projectiles are thrown; and to observe carefully at right angles to the range, how near they fall to the mark; and to prepare beforehand, with all care, both the eye of the marksman and the hands of his crew, to follow with the gun the devious rolling and pitching motions of the ship.

Officers, who as midshipmen, and as sub-lieutenants have mastered the various manipulations of artillery and small arms, should not, when, in after-life, they desire to study in the "Excellent" the principles of war, be committed exclusively to the teachings of foremast seamen. Nor need the course of higher gunnery education be so confined to mere manual drudgery that, even when experienced officers present themselves for the second, third, or fourth time to the "Excellent," the curriculum of artillery studies should be limited to repetitions of the merest elementary physical training. It might be fairly recognized that naval Officers who have during their whole professional career, witnessed daily the movements of heavy ordnance, and, conducted weekly general exercises, and monthly firings, have gained some rudimentary experience; and are not incapable of receiving intellectual culture in the scientific principles of the art of naval war.

The time devoted to the various arms and exercises, as well as to instruction in the principles of naval war, will be seen by the following table:—

Subject.	Sub-Lieutenants.	"Short course" for Lieutenants.	Qualifying for Gunnery Lieutenant.	Seamen qualifying for Gunnery Instructor.	Seamen qualifying for Seamen Gunners.	Appliances, &c., in "Excellent."
	Drill days.	Drill days.	Drill days.	Drill days.	Drill days.	
Heavy rifled gun drill ..	12	23	23	46	23	Obsolete smooth-bore 100-prs. on obsolete carriages.
Truck gun drill.........	5	5	9	18	9	Antiquated truck carriages.
Revolving gun drill.....	2	—	4	8	4	Obsolete 100-pr. breech-loader.
Turret gun drill........	—	—	4	16	8	Obsolete lifting slide, &c.
Gunboat firing.........	—	—	1	6	3	Fixed 9-in. carriage without training gear.
Fuze instruction........	20′ daily	12 × 2 hrs.	9	18	9	
Examination of guns...	—	—	1	—	—	
Infantry field exercise...	3	17	17	34	17	Landing under fire, taking cover, and all seamanlike instruction omitted.
Musketry instruction....	—	—	10	20	10	
Cutlass drill...........	15′ twice a-week	4	8	17	8	No effort to make skilled swordsmen.
Field gun drill.........	—	9	15	30	15	Landing guns, and coast warfare, &c., omitted.
Electricity.............	—	—	17	17	—	Taught by an educated Officer, but without actual naval warlike appliances.
Diving................	—	—	1	—	—	
Theoretical subjects.....	3	—	14 × 2 hrs.	—	—	Taught by an educated Officer, but without adequate appliances.
Manual, leave, and examination.........	8	5	33	25	10	Examinations conducted by educated Officers.
Total gunnery......	35½	63	152	255	116	Battalion landing days and absences from drill not counted.
Mathematics at Royal Naval College......	—	—	141	—	—	The last six or seven of the fourteen months' course.
			293			
Average gross total in months...........	1½	3	14	18	12	Seamen are subject to many interruptions for routine ship's duties.

N.B. One-sixth of the drill time, or about two months in the year, is lost at Portsmouth, owing to the musketry instruction being given on one island about a mile off; field gun drill on another a mile in the opposite direction; infantry field exercise on a Common two miles off in a third direction; heavy gun firing seven miles off in a fourth direction; and many of the other exercises on board a variety of vessels, the squads being all out of sight of the Commanding Officer.

In rainy weather, all these drills have to be imperfectly conducted in the confined space of the "Excellent" and "Calcutta." This lack of space makes it impossible to accommodate more than a small number of the zealous Officers on half-pay who are anxious to employ their enforced leisure in undergoing the "short course" of instruction.

Economy of Gun-power.—Weight for weight the concentration of useful work or power into a few heavy ordnance has produced an economy of gun-power far beyond what the mere correspondence of weights suggests. Even when the target presents a flat surface at right angles to the trajectory; it is found impossible, in practice, to secure the simultaneous impact of numerous projectiles upon the same small spot so as to obtain united effect. And it is evident, that when the face of the target presents a considerable angle to the range, the chances of numerous shot hitting the same spot, even without regard to time, is excessively small. A vast accession of power is gained by employing the same weight of iron in a single shot, which can only hit on one spot and at one time whether the hostile ship presents her broadside at a right or at an obtuse angle. It will be remembered that a single 450-lb. smooth-bore shot from the United States' monitor "Weehawken," shattered the armoured side of the Confederate "Atalanta," and placed so many men *hors de combat* as to decide the action. This was the more remarkable as the "Atalanta's" side presented an angular target, and the shot being of a spherical form, which is unfavorable to penetration, no perforation took place. From our own experience at Shoeburyness it has been deduced that one 68-pounder of 4¾ tons weight firing one 68-lb. shot with 16 lbs. of powder produces the same effect on an armoured target as five 32-pounders of the united weight of 14½ tons, throwing 160 lbs. of iron with 50 lbs. of powder. 17 men armed with a 68-pounder can thus do as much damage as 65 men armed with five 32-pounders. Again, it takes 1,190 men working seventy 68-pounders weighing in all 332½ tons, and throwing 4,760 lbs. of iron, with 1,120 lbs. of powder, to match 16 men working one 18-ton gun, which throws 400 lbs. of iron, with 60lbs. R.L.G. powder. The saving of wages, provisions, and pension in employing sixteen men to do the work of 1,190 men is so great as to throw into the shade the fact that each discharge from seventy 68-pounders, costs £49, whilst that from the 18 ton gun costs only £4 9*s*., or nearly nine-tenths less money. In other words, to preserve the relative offensive powers of the "Hercules" against a similar ironclad whilst changing her eight 18-ton guns for 68-pounders of 95 cwt., that ship must have 560 port holes for an equal number of 68-pounders instead of eight as at present, and must carry 9,520 men for this one purpose if she would full-man each, instead of 128 men if it were desired to full-man the present 18-ton guns. This enormous accession of gun-power obtained by concentration of weight in few guns, forms the chief argument in favour of ponderous ordnance.*

Economy of Space.—In discussing small craft armaments, we have noticed the evils of long gun-slides in vessels of narrow beam. In ironclads, the question of space assumes another and yet more important aspect. Every additional inch of space taken up in working an armour covered gun, involves an increased distance between the ports, and calls for additional armoured side, which adds enormously to the weight carried, and consequently to the size, the cost, and the handiness of the ship. Therefore, in economising space in working artillery in ironclad ships, we economise all the most material elements which enter into the construction and management of these costly vessels. This is what mechanical gun-carriages achieve to the utmost limit. When we contrast the dimensions and the defensive and offensive powers of our first ironclad, the "Warrior," with those of the "Hercules," it should be borne in mind how much the concentration of weight of artillery, and the introduction of mechanical gun-carriages, without which such ordnance could not have been worked at sea at all, have, by diminishing the fighting space, contributed to a reduction of the extent of armour cover, and thus enabled thicker armour and more formidable weapons to be carried by a much smaller ship.

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* See Modern Carriages for Heavy Naval Ordnance, Journal of Royal United Service Institution, vol. x, No. 41, 1866.

Thus the "Warrior" is 9,137 tons weight, partially armoured, with 4½-inch plates; whilst the "Hercules" is of 8,677 tons, and has all the vital parts clothed in 8-inch armour. Yet, until recently, both ships carried the same weight of artillery, but that of the "Warrior" was divided into 32 pieces, of which 28 would have been useless at 1,000 yards against the "Hercules;" whilst that of the "Hercules" is divided into 14 pieces, of which 11 would be effective against a similar ship at that distance. Much of this advantage is gained by concentrating the weight of artillery into fewer pieces, and employing mechanical gun-slides, the shortness of which reduces the space to be covered with heavy armour.

Again, the "Royal Alfred" was armoured before mechanical gun-carriages were generally accepted, and the distance between her ports from centre to centre is 20 feet for her 12½-ton guns, instead of 17 feet as for the 18-ton guns of the "Hercules." From this cause alone the "Royal Alfred" carries about 21 square feet of armour cover per gun more than the "Hercules." If the "Royal Alfred" had been designed to carry the new complete 9-inch gun slide, which occupies 18 inches less space than the imperfect mechanical ones now on board that ship, the distance between her ports might have been further reduced 18 inches. Thus the armoured area might have been 31 square feet per gun less than at present; and this additional weight might have been otherwise employed. This extra cover necessitates a corresponding diminution of its thickness, and weakens her defensive qualities.

Economy of Men.—Mr. H. D. P. Cunningham graphically described before this Institution, in 1866,* the attempt then being vainly made by 24 stalwart seamen gunners to work with tackles and handspikes a 12½-ton gun on the level decks of the "Excellent," in the Lake of Porchester. By the introduction of mechanical appliances, twelve men can now work the same gun with ease, accuracy, and safety, in a heavy sea-way; and 17 is the maximum number that can be made to share the operations connected with the handling of a 25-ton broadside gun. Thus, in 1869, the Captain of the "Northumberland," an ironclad of 10,584 tons weight, pointed out that 751 men was the number specified by the official Quarter Bill for fighting that ship, of whom 474 were required for working her 26 guns, but that the complement allowed was 45 short of this; and he requested that the necessary additional men should be granted. By substituting, for ropes and handspikes at her 9-ton and 12½-ton guns, the mechanical training gear suggested three years before, a saving of 48 men, or about £2,000 a year was effected; and this additional fitting was found to save so much time as well as labour in taking aim with the ship in active motion, that the Commander wrote, "You have no idea the difference our training gear makes; we "practised coming home, and got through nine rounds in about half-"an-hour's very good practice; ordinarily, it would have taken about "four hours, *i.e.*, as we have done before." A further reduction of labour and time, with increased accuracy of fire, might have been attained, had the eccentrics for the rear rollers of the slides been removed and the original design adopted, as in the most recent constructions. These rear eccentrics employ from two to four additional men, and are prejudicial to accuracy of motion. Had this been done, the labour of 100 men, at the annual cost of £3,865 13*s.* 4*d.*, might have been saved, and better results obtained from the same guns. These men would be available for manning prizes or other ships.

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* Journal of the Royal United Service Institution, vol. x, No. 39, 1866.

By diminishing the sail power of ironclads, or by applying labour-saving apparatus to the sails, or by abolishing ornamental evolutions aloft, the complements of armoured ships might, by the thorough introduction of mechanical gunnery appliances, be reduced still more. Such economy in men represents not only a saving of money, but, what is of far greater importance, an increase of power; for the same number of skilled men could be diffused over a larger fleet. This saving of men by the use of mechanical gun-carriages is a matter of no small importance to a country without adequate reserves of skilled men-of war's men. Our wealth may purchase any amount of machinery, but neither gold nor press-gang can create in an emergency human skill in the quantities requisite to maintain the only coast defence compatible with our national existence, viz., the defence of the low-water line on hostile shores.

Economy of Money.—The unhappy fact, that the present bad system of rifling destroys heavy artillery in a few hundred rounds, may be easily obviated by the abolition of the increasing strains at the muzzle, and the introduction of the iron-bearing centering system, which so much official experience has shown to be capable of affording longevity to both gun and projectile. This corrected, the gain of gun-power and the endurance of iron carriages may be set against the circumstance that each 18-ton gun costs about £1,356, and each 25-ton gun about £1,796, and that their mechanical carriages are proportionately expensive. Comparing the few heavy guns with the many small, the first cost is by no means excessive; whilst the saving of costly human labour is so remarkable, that, even if we could imagine such ponderous weapons being worked in a sea-way as accurately and safely by handspikes and tackles as with mechanical gear, the economy of wages, provisions, and pensions, represents a continuous as well as a large daily saving.

Conclusion.—In contrasting the efficiency gained by the employment of machinery for working guns at sea, with the inefficiency attendant upon rope-worked mountings, I have dealt exclusively with accomplished facts. Omitting speculative considerations, I have described, as they now exist in Her Majesty's Fleet, the more perfect gunnery appliances of the "Hercules," "Sultan," "Blonde," and "Raleigh," the inaccurately working slides for 6½-ton guns, and the miserable mountings of the 64-pounders and smaller guns. I have sought to gather up the experiences obtained at sea, and I find that every officer who has witnessed the working of mechanical and of rope-worked carriages in the same ship, when aiming at targets at sea, or in heavy weather, appreciates the numerous and immense advantages which machinery has over tackles, even when the weight of artillery moved is one, two, three, or four times greater. Amongst those who have thus officially eulogized mechanical appliances, or condemned rope-worked carriages, may be mentioned, the Board of Admiralty, in 1869, the late Controller of the Navy, the late and the present Directors General of Naval Ordnance, the present Captain of the "Excellent," Admirals the late Frederick Warden, G. T. P. Hornby, E. Inglefield, C.B., F.R.S., R. J. Macdonald; Captains Vansittart, C.B., Preedy, C.B., Tatham, Willes, Connolly, Luard, C.B., Lord Gilford, the Honble. F. A. C. Foley, E. H. G. Lambert, W. R. Rolland, R. Dew, Marten, J. G. Goodenough, and A. Wilmshurst—the last-named officer having been one of the first to appreciate the merits of machinery for guns.

Turning to foreign nations, we find that none have overcome the difficulties of working ponderous weapons with ease, accuracy and safety in a sea-way, excepting those which have copied Captain Scott's designs. The Chief of the United States' Ordnance Bureau, reported last year that "a large sum is required for alterations in the 10-inch and 15-inch iron gun-carriages," thus showing that the problem is still unsolved in that country. We may, therefore, safely assume that the British Navy, is, in this respect, in advance of all the navies of the world. Shall we then learn nothing from the experiences and reports of our naval men? Or, are these so unworthy of attention, that seamen must continue to be cumbered with inefficient, inaccurate, and unsafe mountings for their smaller guns when efficiency is within easy reach. We have spent much money upon rope-worked carriages which are a discredit to our seamenlike capacity; and also upon only partially effective mechanical appliances for 9-ton and 12½-ton guns, whilst, ever since 1862, the more perfect apparatus now being tardily adopted was within reach. Surely, it is high time to cordially accept the logic of accomplished facts, to discontinue the manufacture of imperfect gun carriages, and to loyally adopt to its fullest extent and for every calibre, the very best means within our reach of "mounting and working guns at sea."

The CHAIRMAN: Gentlemen, I am sure that you have all listened with great interest to the very explanatory paper with regard to the mounting of naval ordnance which Captain Dawson has just read. He commenced by referring to the old mode of mounting guns, and working them by tackles and ropes, what he called "rope work." I am obliged to acknowledge that I was one of the few old-fashioned officers who were of opinion that guns above 95 cwt. could not be worked on board ship. But when I gave that opinion (and other officers with me), it was with the understanding that they could not be worked with the appliances then in use, that is to say, with blocks and tackles. There is no doubt that, without the present appliances, it would be quite impossible to work the present heavy guns. But I cannot exactly say that we ought to be sure that, in case of war, when guns are exposed to shot, we should not have to go back in some measure to the old tackles. As long as guns are mounted in ironclad boxes, or in turrets, where shot cannot get at the carriage or the gun, nothing can be more perfect than Captain Scott's plan. But if they are mounted in an exposed position, and a shot gets in among the machinery, I take it that the only way to go on working guns (if you have not done away with bolts in the ship's side), would be to get up the old tackles, and try to do the best you could in the old-fashioned way. Therefore, I cannot quite agree to throw away the old plan. With regard to the compressors, there is no doubt that Captain Scott's is far the best, and the whole system of his carriage is by far the best; still, I cannot allow that they are quite perfect. I have never commanded one of the ironclads of the present day carrying these heavy guns, but I have gone on board and seen the practice. I happened one day to be on board the "Hercules" with the 18-ton guns. I asked an Officer, "Are these self-acting compressors?" He said, "Oh no, we must attend to the compressor." "I replied, "I do not think the compressor perfect without it is self-acting," because, from my little experience in gunnery and working guns, I find that in general, even with excellently and highly-trained gunners, when they are in a hurry, they screw up the compressors when they ought not, and then do not screw them up when they ought. They told me this sort of thing never occurred now, everything was much superior to what it was in former days; the men were better trained. I was glad to hear it. However, they fired with full charges to try the effect of the new pebble powder. I was standing close to the gun. The gun came bang in about three feet beyond where it ought to come. The Officer said, "Hallo! there is something wrong here." I said, "Oh, I know there is something wrong, it is just what I told you; either the man has screwed it up too much, or he has not screwed it up at all." It was found, I believe, that the man had not screwed it up at all; and if it had not been for the buffer, the gun would have been dismounted altogether. As it was, it broke the T-plate, which Captain Dawson says is of no use. I do not think there was a hook in front of the carriage; the gun was disabled. They would not have repaired that under two or three hours. I merely mention these facts to show that we must not fly to the conclusion that everything is perfect. Again, with regard to these guns, when a ship is lying over, if the ship has no sail—for now-a-days ships have no masts, and, of course, have no sails—but she may take a roll, and if the guns are extreme trained fore and aft, I should be doubtful, if she took a heavy lurch, whether there would not be a great strain upon these cogs. Every seaman who works guns in a sea-way knows there is a great difficulty with heavy guns when they are extreme trained; they are apt to fly fore and aft. Here there is nothing but the frame that is laid down on the deck, and the brass racer. We all know that when a ship is pitching, there is an elevating movement. A gun will sometimes lift right up off the deck, off the rear trucks altogether. If the ship takes a sudden pitch, she will be inclined to lift the hook out of the lip of the front racer, and the gun will fly fore and aft. I do not say this in disparagement of the plan, but these are points that occur to me. I dare say there are other gentlemen more competent to give an opinion than I am.

Vice-Admiral HALSTED: I should like to ask the lecturer a single question, viz., as to whether he has ever contemplated, or whether the lecture at all contemplates the use of muzzle-pivoting as distinct from trunnion-pivoting, with the view of reducing to a minimum the size of all ports, while, at the same time increasing materially the lateral and vertical range of training for all guns, especially broadside guns. As regards turret guns they already train laterally, through the whole 360 degrees, *i.e.*, right round the circle. They are, of course, indebted to the action of the turret for this "all-round fire," which is always available, except that where there are two or more turrets, it is not reasonable to fire one pair of guns into a turret which contains another pair of the same ship's guns. But in such a ship, for instance, as the "Glatton," such a maximum range as that stated above, is the supreme triumph of Captain Coles's great invention. She can fire her two 25-ton 600-pounders right round the whole 360 degrees, perfectly unobstructed; but her ports are anything but minimum ports. As in the case of the "Captain," and as in the case of the "Monarch," there is an open port-space of ten inches above and below each gun of the "Glatton," through which any small-arm party with rifles, or with Gatling guns, or other mitrailleuses, may keep up a very serious fire at all times. Of course, if the gun in these "floating batteries," or the other ships named, is in its upper stage of position, so as to give the greatest amount of elevation, then there is an entire opening of 20 inches above the gun. If again, the gun is in its lowest stage of position, so as to obtain the greatest amount of elevation, (but which is not very great), then there is an open space of 20 inches below the gun through which to receive all destructive fire of that sort. I am not unaware that my own view with regard to turret-armament is, usually placed, though most erroneously, in a position of contradistinction to so-called broadside armaments; I say erroneously, for turret armament, as I well know, is in reality the most perfect broadside armament which has ever been conceived,—as witness what I have stated of the "Command of Fire" of "Glatton." I am, also, not unaware that I am thus at difference, though only apparently, from my friend the lecturer himself. But the particular question of minimum ports for maximum angles of training, vertical and horizontal, whether in turrets or in broadsides, is one which in these days is of very great importance,—nay, of vital importance,—as regards exposure to hostile projectiles. And it seems even more so in the case of turret port-holes than broadside port-holes; because the interior of the turret itself presenting, as a rule, an iron circular surface, a shot which has missed a man on first entering the port need, by no manner of means, miss him again when it comes twirling round from the other side, as we must expect that it will do, unless in the meantime it be arrested. Therefore, I believe, that no trunnion-pivoting gun with its maximum port-hole, can by possibility compete "*cœteris paribus*," against an efficient muzzle-pivoting gun with its minimum port-hole, whether the guns be mounted in broadsides or turrets.

Vice-Admiral Ryder: I should like to make one or two remarks; the Chairman alluded to the great difficulty there would be when these heavy guns were trained fore and aft, and were run in to prevent them from swinging down to leeward athwart ships when the ship lurched. I had the opportunity on board the "Hercules," off Lisbon, of watching what took place; it was on an occasion when I went on board with Sir Thomas Symonds to see these guns worked when the ship was rolling. The 18-ton guns were trained nearly fore and aft, and fired through the embrasured ports which she has for that purpose. When the guns were in for loading (because that was the dangerous time), if the ship rolled heavily, the tendencies of the guns were not to fly fore and aft, but to fly athwart ships as the ship rolled,—not to capsize, but to swing down to leeward athwart ships. The man who was working the winch, who no doubt was a selected man, a careful, steady man, who had a great deal of practice at it in smooth water, was thrown with great violence right over the winch, and jerked ten yards off; he might have been killed; that is the risk. The man begins training, there is no check, no break, and the risk, if the ship gives a lurch, is, that the winch overtakes him (very often with a *sailor* his serge frock is caught in the machinery), the man himself is thrown a considerable distance, and the gun takes charge. I spoke to Captain Scott about it, and said "this is a point of great importance, which you ought to meet." The lecturer has told us that there is a plan designed, as I understood him (he will correct me if I am wrong), by which this difficulty is to be met. He spoke of a beam-compressor on a small scale, which is to be applied. If a man has to work the winch with one hand, and has hold of the lever of the little compressor with the other, which I suppose he may have to do, I doubt whether anything of that kind, if the ship is rolling much, and the gun is in that position, will bring the gun perfectly under control. At all events, the difficulty must be met, somehow, some solution must be found for it. It is of great importance, because when we are in chase or running down on an enemy, the guns trained fore and aft, or nearly so, will be the guns that will be in principal use. A rear pivot bolt for securing the slide to the deck would be I believe the safest plan. The lecturer alluded to the difficulty in firing turret guns, if a ship had any list, of being able to command the *whole* of that large arc, which you can undoubtedly command with turret guns, when there is no list, and the ship is on an even keel. But in case of fighting without sail, for the future, we shall not be puzzled by any difficulty of the ship having a list of one degree, or three degrees, for the ship will be almost certain to be rolling through an arc at least equal to the latter, and the mark will be brought on, in the way in which we practical gunners know it is brought on, viz., by the motion of the ship; and the cleverness of the man firing the gun is shewn in anticipating and utilizing the motion of the ship, so that when the mark is brought on by that motion he fires. On shore it is very different. On shore you point your gun accurately at the object you wish to hit, allowing something for windage, and then you are certain to hit your object. With us it is totally different, the motion of the ship brings the object on. Therefore, I think the lecturer has in this respect been a little hard on the turret gun, compared with the broadside gun. In speaking of turrets, he made some allusion to the weight of the turret, which will have to carry these heavy guns. I believe I am not overstating it in saying that a turret with 12-inch armour, with appropriate backing, to carry two 35-ton guns, will approach with the guns to very nearly 1,000 tons, at all events, it will be over 800 tons. (The Chairman: Two turrets?) No, each turret with 12-inch armour. At all events, it will reach that if you go on to thicker armour, to the armour which the great artillerists, Whitworth and Armstrong, think necessary to keep out the shot which they anticipate, being able to provide us with. This is one of the difficulties ahead of us who have advocated turrets, viz., whether we can still hope to revolve turrets of this enormous weight, *steadily* in a sea way, or whether we must seek some other way of protecting the gun than by the turret, as for instance, by fixed towers, the guns *en barbette*. This is a difficulty which will have to be met. The lecturer said, as I understood him, that one of the demerits of turret ships is, that they are not suitable for carrying troops. In so saying, he evidently has not studied the different forms of turret ships which have been proposed. Of course, we are acquainted with the turret ships we have got in our navy; if you take the "Monarch," I do not imagine she could carry many troops, I doubt whether the "Devastation" could carry many troops, but he did not mean merely that the turret ships we have got could not carry many troops; but that there was something in the "turret," which prevented your applying it to a floating body which could carry troops. I think he is wrong there, the turret can be applied to a floating hull, which can be as capable of carrying troops as the purely broadside ship. Perhaps, in his answer, the lecturer will tell us why a turret ship cannot carry troops?

Captain Selwyn, R.N.: I will ask Captain Dawson a question, which I think touches the future work before us very closely. Would he tell us what implements are now used in the way of guns and gun-carriages to train the Naval Reserve of England, and the naval gunners of England? Are they the carriages that are likely to be used in the future? or, are they managed with ropes and handspikes? Because, I think, whether these mechanical appliances be always as reliable as some think, or as little reliable as others would have them to be, it is at least wise that our seamen should be trained to understand them, not that they should be put to deal with ropes and handspikes, exclusively, until the moment when they are called upon active service, and that they should, then, be put for the first time to appliances, which it must be admitted require some considerable knowledge of their use, and great steadiness. Captain Dawson has very fairly put an objection which I have often heard in this theatre, to the question of firing through your own decks in a turret ship. You may depend upon it, in the smoke and heat of action, men do not always take such wonderfully accurate shots. They are apt to let go the gun when they are only thinking they are going to hit; and it is a very serious thing if a roll has brought your own deck between you and the object, and you send a shot through that. Moreover, we should recollect in our estimate of the comparative exposure to which Admiral Halsted spoke, that not only is there much more exposure of the whole turret, but, if you happen to have an enemy to leeward of your turret, directly your ship begins to heel over, the whole interior is open to view, open to the impingement of any shot. It is not a casemate, it is a battery *en barbette* so to speak, or very little more. It has a side above the gun, but with any inclination of ship, or to a higher placed gun than its own, the turret arrangement is such that actually when the gun is run in, it is exposed to the shot of the enemy, without any protection. As regards the weight, I thought that question had been settled here, that you could not with the modern requirements for flotation wisely carry a deck cargo of 800 or between that and, as Admiral Ryder says, 1,000 tons for each turret, exclusive of the guns. I thought it had been shown that, even without any sails, or any modification necessary from the use of sails, that the mere fact of driving a steam vessel heavily armed, with low decks, against a sea might induce a condition which may turn that vessel over, and incline her to assume what I am sorry to say, is the normal position of every iron-clad to-day in the service that has not been ballasted, that is, "bottom upward." There is not a single ironclad vessel that we have, whose curve of stability reaches 45°, consequently, the instant she is allowed to go over beyond a certain heel, I need not say far short of 45°, the so-called curve of stability—she seeks to assume a normal position, bottom up. These "curves of stability" ought long ago to have been denominated "curves of instability;" for, then, they would have warned seamen what they must do, and what they must not do, instead of telling them broadly, "Well, your ship will be very stable up to this point, it is for you to see that no wave or other cause, ever makes her go farther." With regard to the question of the compressors, and of the mechanical inventions comprised in that gun carriage, I must draw your attention to the fact that the very finest and most essential part of the whole system is that mixture of wood and iron in the compressor. There is something much beyond what appears in it as a simple compressor. If it were all made of iron, you would utterly fail of your effect. If it were all made of wood, you would utterly fail of your effect. There is a vibration set up, which Mr. Oliver Byrne integrated for you; there is a vibration set up between those pieces of wood and iron which no other arrangement would have accomplished. Other people have tried to imitate that by a different arrangement of iron, and they have totally failed. That is a point worthy of consideration when we think—to the honour of naval gunners be it said—that a naval gunner has been the first to apply in practice that very artistic condition. As regards the question of racers, and of the liability to jump off those racers under any conditions, I do not think there is the slightest difficulty in making that rail of such a form, a T-headed rail, as that it will perfectly keep down the gun. I, not less than Lord Lauderdale, think that tackles and breechings are very good and useful things when you have not got anything else. But we have got an immunity from shot which we had not before, else we could not have these mechanical gun carriages and other labour-saving appliances which we rejoice in on board ship to-day. But I think it is worth consideration whether tackles and breechings, or any plan we can put there, if shot once penetrate the ship, would be of any value at all? I do not think, with our old wooden carriages, you could get such a gun into action at all; you could not move it in the way it is now necessary to move such enormous weights, and if the carriage is once disabled, your gun can only be regarded as *hors de combat* for that day. Therefore, we shall not have to use tackles until long after we come out of action. Captain Dawson has told us that we have a few guns in a wretched state, not of explosive bursting, but of disabled bursting; because when the subject was mentioned in another Institution the other day, Major Palliser took occasion to say that the guns that had burst in the Navy, had not burst explosively. I think nava men will agree with me that if you have only a small number of guns on board ship, it does not matter as regards the fate of the action, whether the guns burst so as to be disabled or burst explosively, even, if in the latter case, one or two of your men have been killed. I hope that the result of this discussion will be, that increased attention will be paid to mechanical appliances on board our ships. We have got an enormous amount of mechanical talent in this country. We ought to employ it, and we ought to institute much more extended, more costly experiments, that we may not have to pay for the excessively costly experiment of finding things fail, when our whole reliance is placed on their being trustworthy in action against our enemies.

The CHAIRMAN: If no other gentleman has any question to ask, I will call upon Captain Dawson to reply.

Captain DAWSON: I am exceedingly obliged to the distinguished Officers who have so kindly commented and remarked upon my paper. I have endeavoured to deal with accomplished facts, and with the practical experiences gained with actual appliances, rather than to go into speculations of my own. Having no personal experience whatever of mechanical gun carriages, I am obliged to rely for my facts upon the opinions and information expressed in numerous official reports; and in the communications I have received from many Captains now in command, or who have been recently afloat, and from Gunnery Lieutenants and Warranted Gunners. I have thus taken my information from practical men, of all ranks, who have had the handling of heavy guns at sea, and whose comments I have endeavoured to condense and present to you. I have merely gathered up the actual experiences of Officers on shipboard, and given you their experiences, without attempting to express unsupported opinions of my own. There has been a great deal of experience gained at sea, with reference to mechanical gun carriages, there being upwards of 300 heavy guns mounted upon them afloat. Only a few of these have the complete apparatus, as it exists in the "Sultan;" the others being more or less imperfect. It is very creditable that, considering how suddenly mechanical gunnery appliances were introduced, and that they were put into the hands of untrained seamen, who had not, heretofore, been in the habit of handling machinery of that kind, they should have managed so well that there has not been in the course of six or seven years, a single serious accident whilst working these very heavy weapons in weather, in which, in former days, we should not have dreamt of casting far lighter guns loose at all. That is a fact which speaks for itself. Incidentally, Admiral Ryder answered the noble Chairman's difficulty as to the deficiency of control over the movements of the "Hercules" 18-ton gun. It is desirable to effect the purpose of working guns, with as little machinery as possible. Experience alone can teach what is the minimum amount of machinery required. The "Hercules" was the first ship to carry 18-ton guns; and the carriages are not so perfect as the ones subsequently built. But, Lord Gilford testifies that they have been worked in gales of wind as securely as if the ship were in dry dock; and that the men of the "Hercules" have the greatest confidence in their gun carriages, even with whatever imperfections they may have. The compressors are now self-acting, though it is impossible to provide against all human ignorance and carelessness. The deficiency as to training arose from there being no controlling brake (Fig. 9, *c*, pl. XVI.) These brakes have now been provided, and I need hardly say would have been provided years ago but for the obstructions to which I referred. Until official obstructions and old prejudices were overcome, perfect mechanical appliances could only be introduced bit by bit, though they were actually designed some years ago. It is most wonderful that the "bit by bit" plan has succeeded so well, and that with so many imperfect and incomplete mechanical gun carriages in the service, so very few and such trifling accidents should have occurred; not a single accident to life having resulted as the immediate consequence of such obstructiveness. As to shot destroying machinery: if even a 7-inch shell of 115 lb. were exploded in an old wooden carriage, and another exploded in the Scott gun carriage, I think the effect would be very much the same, and that the difference would not be worth talking about. The point, however, of machinery getting out of gear from less causes has been anticipated, tackles being supplied to all ships carrying mechanical gun slides. The gun slides are also provided with suitable eyebolts, so that tackles can be made use of for the purpose of training; and no doubt in fine weather, and by quadrupling the gun's crews, they will effect their purpose in a rough and inaccurate fashion. Recently, I found on board several ironclads in the Steam Reserve, tackles placed overhead in the batteries ready for use, as in olden times. Admiral Halsted has dealt with me very tenderly, considering that my conclusions with reference to turrets were not those which the gallant Admiral has so long and so ably advocated. I had no intention of dogmatizing between the turret and the broadside; but have endeavoured to reason upon the question as a gunner, dealing solely with gunnery. I have consulted with those who have served in the "Monarch," and find that they speak very highly of turrets; whilst those who have served in the broadside ships speak highly of broadside guns.

Admiral HALSTED: Is the "Monarch" a turret ship?

Captain DAWSON: She is called a turret-ship. In dealing with turret-guns, as with the broadside ones, I have taken the experience of others. I have dealt in speculations only so far as to what the "Fury" may be expected to do when she is afloat. Admiral Halsted asks me to go into the question of "muzzle-pivoting" *versus* "compound-pivoting." (Admiral HALSTED: I asked you if you had considered the question of muzzle-pivoting.) My statements have had reference to what actually exists on board Her Majesty's ships, and there is no plan of muzzle-pivoting existing in Her Majesty's ships. But the present system of horizontal-pivoting amounts practically to lateral muzzle-pivoting for training, which is one of the points involved. I think it would be very unwise to reduce the dimensions of broadside-ports to the size of the muzzle of the gun, even if it were possible. For it is most important that the captain of the gun should be able to see the foe. In these days, ships are apt to be turned by their helms very rapidly, bringing, in a general action, a great number of different ships in line with the sights in a very short time; and it would be very difficult, looking out from a narrow port, to tell which vessel is an enemy and which is a friend. (Admiral HALSTED: Not a narrow port.) I speak of the horizontal width. To meet that difficulty, this particular port (Plate XIV, fig. 4), has been devised for the "Sultan." You observe, it is intended to give as much lateral view as possible for aiming, whilst narrowing the port to the utmost, below the field of view. (Admiral HALSTED: That is as a broadside ship.) As a broadside ship. The question of "compound-pivoting" for a broadside ship has been thought of with the view of reducing the vertical height of the port.

Admiral HALSTED: I do not understand what you mean by "compound-pivoting." My question had reference entirely to "muzzle-pivoting."

Captain DAWSON: The object of "compound-pivoting" is to reduce the vertical height of the port. The object of "muzzle-pivoting" is to attain the same object. I object to the size of the port being reduced laterally for broadside ships beyond the present limits. I have only dwelt upon things as they exist, not as they may exist some other day. The controlling brakes for the training gear, to which Admiral Ryder refers, have been attached to the existing mechanical gun slides. The men who work the winches are evidently not the men who would control the brake. This control would be in the hands of a responsible man, probably the second captain of the gun. (Admiral RYDER: Is there one in use at sea?) Yes, they have been for some time in use in recently commissioned sea-going ships, and wherever machinery is employed, except in the gunnery, drill, and training ships. Besides the usual controlling brakes, those guns that are likely to be employed in a fore and aft line are provided with an additional self-acting brake. There is one in use in the "Hotspur;" but I do not know that that one is so perfect as it might be; a much better one has been devised. The 25-ton broadside gun in the "Hotspur" (Pl. XV, figs. 5, 6), has been used in such weather, that the First Lord of the Admiralty thought it necessary to use "extreme caution" with reference to the safety of the ship. So I suppose that the gun-slide was pretty fairly tried as to bad weather. I do not share Admiral Ryder's difficulty, as to contriving machinery to rotate a turret of 1,000 tons weight. No doubt, that would be easily overcome. Perhaps, my referring to the present turret-ships being unable to carry troops was out of my special province, which is to look upon the question from an artillery point of view. Looking at the high hurricane decks and walls of the coast defence turret-ships, I imagine that the action of the wind upon so large a balloon-shaped surface will be to heel the ship over a degree or two, and, in that case, their guns will be useless when trained upon the bow or quarter. As to the reduction of shock of recoil upon the gun-slide, and consequently upon the deck, due to lowering the height of the carriage, that may be illustrated by assuming an extreme case (Pl. XIV, fig. 1). Let us imagine a very high and very short carriage on one slide, and a very low and very long carriage on another slide. Let the gun be fired horizontally, and the shock of recoil will, in the first instance, be also horizontal. But the shock is communicated to the slide by a lever, represented by the vertical height and the length of the carriage. In the case of the very high and very short carriage, this leverage will be most powerful, tending to overturn the carriage backwards, and concentrating the effect upon a small area at the rear chock. But by lowering the trunnion and lengthening the bracket, this leverage is proportionately reduced, whilst a longer surface is provided for absorbing the recoil. You thus gain doubly, first by having a less shock on the slide, and secondly, by diffusing and absorbing the concussion. Hence the same decks and beams will sustain the firing of heavier guns by the use of low carriages and high slides than before, the trunnions being preserved at the same height from the deck and from the water-line, in both instances. Captain Selwyn asked what gun carriage is in use for training boys. The gun-carriages employed for training boys are copies of those in use many reigns before that of Queen Anne ; whilst the Naval Reserve are also trained to handle those gunnery appliances which were in use long before the reign of the same good Queen. I am told that there is in each Naval Reserve drill-ship one rope-worked slide, of a subsequent date.

Admiral RYDER : Numerous guns are worked.

Captain DAWSON : They are all worked upon antiquated trucks, excepting one in each drill-ship mounted upon the worst rope-worked slides. The seamen in the depôt ships and in the Naval Barracks are similarly trained to use antique specimens of gun mounting. Seamen gunners are trained to the use of mechanical slides in the "Excellent" and "Cambridge," but the gear is of obsolete patterns, and the guns cannot be fired from them. True, seamen gunners do fire from a 9-inch gun mounted upon a fixed slide in gun-boats outside the harbour; but inasmuch as there is no training gear, there is no controlling gear. Therefore, neither officers nor seamen, qualifying as instructors in gunnery, ever see what effect firing the gun has upon the training gear, or how the controllers are used outside the harbour, or any of the other movements connected with the management of the new mechanical gun carriages, when firing guns. The Gunnery Ships have also other gun boats for training instructors to fire from rope-worked slides. Thus, neither boys, nor seamen, nor Naval Reserve men, nor future gunnery instructors, nor officers are taught in the harbour training ships how to handle the gunnery appliances actually in use at sea. But no pains are spared to impart in the several training ships a thorough knowledge of the working of all the antiquated and obsolete gunnery apparatus. The instructors do their very best with the appliances at their disposal, and teach most admirably a great deal that they know to be utterly unpractical and useless. No one deplores this waste of teaching power more than the instructors themselves.

The CHAIRMAN : I give the thanks of this meeting to Captain Dawson for his very interesting paper. I am sure it is most interesting to all naval men, and particularly to those officers who have not been employed lately, and who are not conversant with these new appliances. I hope we shall ere long hear from him again upon the same subject. I may mention with regard to Captain Scott, that we are all much indebted to him. I believe I may say that I was the first officer who inspected his new carriage—I think it was on board the "Research"—I do not know how many years ago ; I think I had the pleasure of reporting favourably of it then.

Note.—Space prevented my going into the question of "eye-training" at sea, but I was in hopes that a matter of such vital and increasing importance would have been touched upon in the course of the discussion. I regret that Captain Poore, Royal Marine Artillery, is not able to be present to explain how his miniature target follows the roll of the ship, and becomes fixed in position upon pulling the trigger line. His device appears to give all the advantages of the old lever target, with the additional gain of training the whole gun's crew to comply rapidly with the requirements of their Captain whilst taking aim. Whilst so much care is bestowed on ornamental exercises, it is a great pity that that which is of far more importance, the training of the eye, should receive such slight attention. The class of certificate given to officers and men passing out of the gunnery ships is dependent far more on a retentive memory as to weights and measures, and petty dodges of drill, than upon skill in shooting, and no means exist for combining aiming with heavy gun dumb exercise at sea.

Next in importance to the artillerist to knowing all about one's own ship, is a knowledge of the protected and unprotected parts of hostile ships. This might readily be imparted by placing in every ship's battery a few plates, shewing the armoured and unarmoured portions of various classes of foreign vessels with the smallest gun which would penetrate the several parts at 1,000 yards' range marked upon each part. Such knowledge would be far more valuable to the seaman gunner than half the figures and dodges with which his memory is loaded at present. The whole subject of artillery education in the Navy needs reconsideration, with a view to re-modelling, being at present far behind the requirements of the day and the attainments of the sister service.—W.D.

Evening Meeting.

Monday, May 27th, 1872.

Vice-Admiral A. P. RYDER, in the Chair.

NAMES of MEMBERS who joined the Institution between the 20th and 27th May, 1872.

LIFE.

Call, C. F., Lieut. R.E.

ANNUAL.

Muir, W. Mure, C.B., Inspector-General of Hospitals.
Talbot, Hon. Reg. A. J., Captain 1st Life Guards.

ON THE LIGHTING OF H.M.'s SHIPS.

By Captain P. H. Colomb, R.N.

Every naval Officer will readily admit the importance of the subject we are to discuss to-night, and perhaps some are partly aware of the difficulties it presents. It is one where the principles lie upon the surface, but their application in a practical form can only be attained by dint of the veriest plodding. As will be seen hereafter, successful revision of the systems of lighting now in use afloat, means victory over an infinite host of small enemies, aggravating obstructions, and wearying details: consequently it is not very easy to draw up a paper on the subject which will contain many central points of interest; yet it is well that the Journal of the Institution should contain the record of an attempt made, by order of the Lords Commissioners of the Admiralty, to improve and re-model the lighting arrangements of the Royal Navy.

The systems now in use have grown up during a long course of years, have been added to or modified from time to time as pressure was felt in one way or another; but it has not been till now that a comprehensive view of the requirements of the Navy has been taken, and that a complete system of lighting has been launched.

I think I can best introduce the subject by taking things as they are now, stating the principles which ought to govern them; how the existing arrangements offend or agree with these principles; and what is proposed in lieu.

The question divides itself into two branches: first, the production; and secondly, the distribution of light. At present we use two sources of light—colza oil lamps and stearine candles. The former are used in all engine-rooms and in the saloons of troop-ships, also in certain lights for exterior use, such as bow and masthead lanterns, &c. The latter are employed for every other purpose. It will be asked whether it is intended to substitute in the revised system any others for these sources of light? Gas, for instance, has been suggested with some plausibility. It may be hereafter that at least a portion of our ships will be lighted with coal or other gas. I know that every now and then attempts are made to introduce it into the Royal and mercantile marines of this country. No thoroughly successful effort of that kind has come directly under my notice, but hearsay evidence tells me that some success has been attained in large ships sailing out of Liverpool. The steamers of the London and North-Western Railway Company are attempting to bring gas into use; but that attempt is no guide for us, as the gas is not made on board. The objections to the use of gas afloat at present, are space occupied in its manufacture; the great probability that it can never be used in the smaller class of vessels, and that therefore we should have two systems of lighting instead of one; and lastly, the danger of explosion,—not perhaps a very remote one. But there seems to me to be a general line of argument which for the present removes the necessity of considering the gas question; that is,—as I shall I think be able to show,—that we can have from candles alone about one-third more light than we now enjoy afloat without incurring any extra expense, and probably with a very considerable saving of trouble. It is in fact not impossible that we can have a complete fulfilment of our wants in the way of light in Her Majesty's ships, without travelling beyond the sources of light to which we are accustomed, and yet show a handsome return in the shape of a saving for the Chancellor of the Exchequer. Respecting paraffin (and the astonishment I have sometimes heard expressed at our neglect of so cheap and simple a source of light!) we have two objections to make—its dirt and its danger. As to its dirt, anyone who has experience of paraffin lamps and of the facility possessed by the oil for making its escape therefrom, and who will imagine a number of them transported to one of the ships in the Channel Fleet, will see very good reason in the objection. As to its danger, we are constantly told that this can be removed by raising the temperature at which the liquid gives off inflammable gas. But if we raise this to the same point as that of colza oil, we can only burn it in colza lamps with just the same inconveniences and probably not at less cost. All that makes paraffin such a valuable illuminant is its low "flashing point," as it is technically called; and though I know of a mineral oil, whose flashing point is as high as 145° Farenheit, which will burn in ordinary paraffin lamps, such an oil would be almost explosive in the event of fire near the store.

If the question were a cheap light only, no doubt paraffin, or even colza oil, might be applied universally. But the real question is not a cheap light, but such an one as will answer all the requirements of a man-of-war; shall be simple, cleanly, easily managed, and permanent, without manipulation. We ought to be, and would be, no doubt, quite prepared to adopt a very expensive light, provided only we could have enough of it, and its use removed all cause of complaint.

No attempt, therefore, has been made by us to employ other sources of light than stearine candles, and colza oil, where candles cannot be used: and much can be done within these sources of light.

We find on inquiry that five different kinds of wick for oil lamps, and that five (or, till quite recently, seven) different forms of candle, are employed. It is probable that these varieties are capable of reduction. A very cursory examination, moreover, shows us that there is very great waste both of oil and stearine, in two directions: oil overflows, stearine melts away and is never consumed at all; or, both being consumed, they pass off in smoke instead in of light. There may also be other waste, not of the substance, but of the light after it is produced. This we shall observe as we go on.

As I shall have frequent occasion to refer to the terms "candle-power" or "candle-light," it will be as well to remind you that light in England is measured by what are called standard candles. The standard is a sperm candle made on purpose, which consumes 120 grains per hour.

The value of a candle as a source of light for ships' use, consists in its simplicity; the permanence of its light; and its cleanliness. The objections to oil are its complication, its want of permanence, and its dirt. The loss from smoke in oil lamps is infinitely greater than from candles, and without glass chimneys, whose use is always to be deprecated afloat, there is great loss of light from this imperfect combustion of oil.

The difficulties connected with candles are the cost of their light, which may be taken as double that of colza oil when properly burnt; and the limit placed on the power of a single candle by heat. While the power of a single oil light may be almost indefinitely extended, no single candle has yet been made efficient which gives a light greater than about three standard candles. The difficulty which this creates will be understood by-and-bye.

When it is proposed to revise the candle-lighting arrangements of our ships, manifestly the first thing to be done is to get at the facts connected with those candles now in use. I will, therefore, give you the values of the five kinds of candles used generally in the Service.

No. 1 is the Police candle, giving a light of three candles, burning twelve hours and three-quarters, its light costing nearly tenpence per twenty-four hours.

No. 2, the Fighting candle, giving a light of 1·6 candles, lasting seven hours and twenty minutes, and costing rather more than 5*d.* per twenty-four hours.

No. 3, the Signal candle, whose light is only 1·3 candles, but whose cost per 24 hours is the same as the fighting candle, and which only lasts five hours and three-quarters.

No. 4, the Eight, which gives the light of one candle, burns for six hours and three-quarters, and costs 3½*d.* per 24 hours.

No. 5 is the Twenty-four, which gives the light of one candle, burns for two hours and a quarter, but costs more than 3½*d.* per 24 hours. If we establish a figure of merit for these candles, dividing the light by its cost, we get the following order:—

Fighting candle	.. ..	= 7·8
Police ,,	.. ..	= 7·4
Eight ,,	.. ..	= 6·7
Twenty-four ,,	.. ..	= 6·3
Signal ,,	.. ..	= 6·1

So that the fighting candle is the most economical of the whole, and the signal candle the least so. These two candles, however, are precisely the same in price—9*d.* per lb.,—substance, and wick. They differ only in diameter, which is a full explanation of the phenomenon, and assures us that what ought to be light passes off in smoke. There is a relation between the size of the wick and the diameter in every candle, which, when properly adjusted, makes it perfect. If the diameter be too large, more substance is melted than the wick can take up, and we get what candle-makers call a wet cup. If, on the other hand, the diameter be too small, the supply is not great enough for the length of wick exposed, and we get a yellow, smoky flame.

Having thus ascertained the facts as regards each candle now in use, the next step is to go minutely into the expenditure of some single ship, so as to get at the amount of light actually produced. If we find this ship expending stearine sufficient to produce an ample supply of light, and being yet badly lighted, we shall know that there is waste somewhere which we may be able to turn into light. If, however, we find otherwise, we may simplify the arrangements, but we cannot give more light without spending more money. Whatever the result, if the ship chosen be an average specimen, we may apply it to the whole Navy with confidence.

Through the kindness of the Paymaster and Officers of the "Monarch" during her last commission, I was able to make this minute examination of her. I must premise that she was anything but well lighted, and that the cost in candles alone was £515 a year. She burnt annually 4,873 lbs. of police candles, costing £168; 5,282 lbs. of fighting candles, costing £197; 98 lbs. of signal candles, costing £4; 538 lbs. of eights, costing £17; and 3,643 lbs. of twenty-fours, costing £129. Taking this expenditure, and the table already mentioned, I found stearine enough was consumed to keep the light of 102 standard candles day and night, without cessation, all the year round. That sounds a great deal, but we must go a step farther to see whether it is or no. The whole space to be lighted in the "Monarch" amounts roughly to 186,000 cubic feet, and the large edition of the printed Instructions can be read midway between two candles 20 feet apart. These points may form our judgment, for a ship would not be badly lighted when the Instructions were legible in every part of her. So using them, it seems that 25 standard candles would be sufficient to light 186,000 cubic feet as proposed. It must now be remembered that only a small portion of the ship requires candle-light all the year round, most parts for but half the year, and many only for a few hours a day. On the

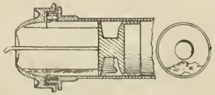


Fig 1.

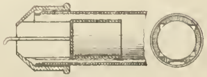


Fig 2.

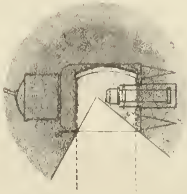
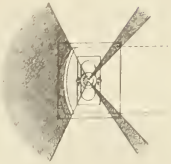


Fig 3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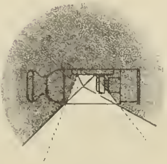


Fig 5.

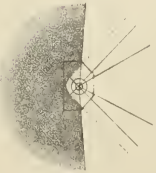
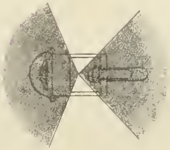


Fig 6.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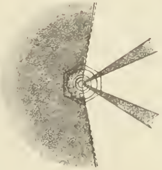


Fig 8

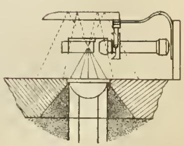


Fig 9

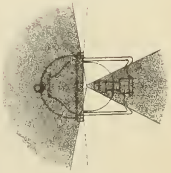
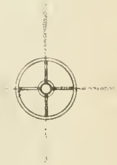


Fig 10.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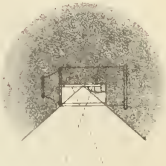


Fig 12

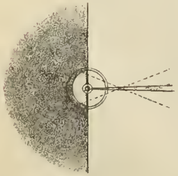


Fig 13.

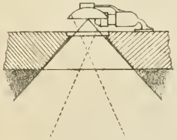


Fig 14.

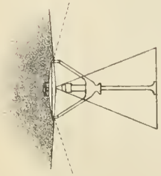


Fig 15.

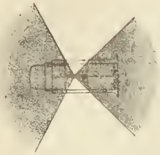


Fig 16

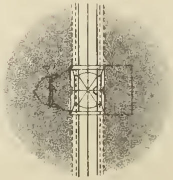


Fig 17

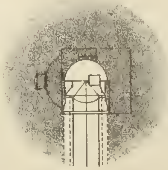


Fig 18.

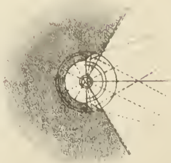


Fig 19

J. Jobbins

Fig. 1.

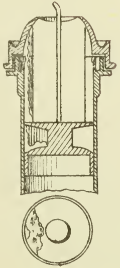


Fig. 2.

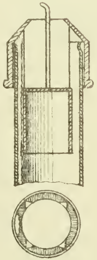


Fig. 3

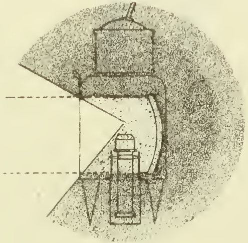


Fig. 4.

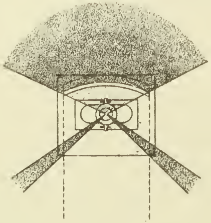


Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8

Jobbins

other hand, there are many parts, such as seamen's messes, which for a time want more light than that mentioned. The spaces are also very much cut up, and many objects below obstruct light. Yet, looking at it how we will, it is impossible not to be satisfied that there is in a ship like the "Monarch," and by consequence in every ship of the Navy, a very great waste of light; the stearine disposed of, ought to give ample light, and the object of our enquiry should be to trace out the loss, and turn it into illumination.

The waste may arise in the failure of the stearine to pass into light, or in the destruction of, or failure to employ to the best advantage, the light produced.

Let us take first the failure in production of light. This may either come about because the stearine is not burnt, or that, being burnt, it goes off in smoke. I have already shown, in the instance of the signal candle, how the latter waste takes place, and I need not dwell upon it longer here, than to note some loss on this head in the police candle, and to mention the remedy, which is simply to ascertain by experiment in the particular candle to be adopted, what that diameter is which will obviate all smoke.

The loss on stearine which is not burnt, is probably more important than the foregoing, and involves some practical details. We have candles fulfilling the same office which burn side by side, one of which lasts between 12 and 13 hours, and the other between 7 and 8 hours. In the "Monarch" there were something like 40 of these. It follows that the labour of replacing them is something serious. I take it as only natural that though the candles vary in their periods of burning, the lamp-trimmer's visits do not, so that practically a candle burning nearly 13 hours is only allowed to burn 12, and a candle burning more than 7 hours is only allowed to burn 6. The very obvious remedy here is to employ candles burning for the same time, which should be a measure of 24 hours.

The police and fighting candles are burnt in tubes, with a spring piston or plunger, which presses the candle up as it burns away. The pistons, as ordinarily manufactured, fit the tubes nearly tightly; as a consequence, the very smallest escape of the melted substance in the inside of the tube is sufficient to fix the plunger. The candle then burns away and is destroyed (Fig. 1). This is an accident very familiar to every one on board ship, and the remedy appears to be that shown in (Fig. 2). The plunger instead of nearly touching the tube with its whole circumference, only does so with four sharp edges or feathers. It then takes an underflow of an unusual extent to fix it in the tube. I believe this remedy is nearly perfect, and will obviate almost all the waste now taking place in this way afloat.

Signal candles we know in the old pattern lantern wasted enormously. That is remedied in those now supplied (pattern shown). There is probably very little loss on the *eights*, which are not burnt in tubes, and in any case, it would be an insignificant matter. It is different in the 24's. Government spends nearly £12,000 a-year in these candles, and probably £2,000 a-year goes in the ends. I calculate that these are the most expensive candles in use, and I must own to a particular desire to see them disappear. If these are burnt in their appointed lanterns or sconces, one-eighth of every candle *must* be wasted, but every Commanding Officer and every Paymaster can testify that what must go to waste is a very small measure of what does. The control over their issue must be always difficult to maintain, for a ship like the "Monarch" issues 87,000 of them yearly. If we were to keep 1,900 of them burning side by side night and day for a year, we should not reach that year's expenditure in the Navy. Here again the remedy would appear to be to use larger candles in tubes, as the loss upon each would be actually less than on one of twenty-fours, and therefore, relatively very much less.

So much for the stearine which, from various causes, is not allowed to pass into light. Now for the light which from other causes is not allowed to illuminate.

We must first remember that the rays from any source of light will illuminate equally the interior of a sphere surrounding it, and of which it is the centre. Economy in the distribution of light is then obtained by diverting the rays from those directions where they are useless into those where they are useful. We very rarely indeed require light in every direction, and our ingenuity may always be applied in the process of directing it.

In the Navy there are two distinct employments to which light is put, one to make its presence visible by lighting up surrounding objects, the source of light being better concealed; the other to make its presence visible directly to the eye. All the interior lighting is included in the first class, and all the exterior lighting in the second. It will be manifest that a totally different method must be pursued in each of these two classes of requirements, and that what is the best method of developing light in one case, may prove to be the worst in the other.

If we consider where light is wanted in the illumination of a space such as a deck or compartment, we observe that it is only overhead, about the beams, where it can be spared. The deck, bulkheads, and sides, require not only light, but an equal amount of it. If it is taken away from the deck to be thrown on one bulkhead, although the light there may be twice what falls on the deck, yet the general illumination of the space will, so far from being improved, be rather deteriorated. So if light be taken from one bulkhead and thrown upon another, there there will be general loss, though one part will gain. If, however, light be taken away from overhead and transferred to the deck, sides, and bulkheads, there will be general advantage, because light is not originally required overhead.

In the case of lights for exterior use, signal-lights, &c., none of the rays which are not nearly horizontal are of any use at all, hence all other rays may be turned from their original directions into such as are nearly horizontal with the clearest advantage. In many cases, again, lights such as bow and masthead lights, do not require to be seen all round the horizon, and therefore after all the rays have been made horizontal, they may with further advantage in such cases be taken away from those parts of the horizon where they are not wanted, and directed to those where they are necessary.

Rays of light can be turned or bent, either by refraction or reflection, but always lose some of their power in the process of bending. The power of rays, when direct, varies as the square of the distance they have travelled from the light. At 20 feet from a candle there will be only one-fourth the light there is at 10 feet; or, in other words, four candles distant 20 feet, will only give the same light as one candle at 10 feet. In the case of interior lighting, the goodness or badness of the illumination does not depend upon the actual quantity of light let out into the space, but first on the area of surface on which the light falls, and next on the condition of the eye. The electric light itself, directed into a space as a single beam, and falling on one surface in a round patch of light, will not illuminate the space so well as an Argand lamp, whose rays are allowed to fall on all sides.

No space can be illuminated better than by the light of day, and the peculiar advantage of daylight is the immense diffusion of its rays. They come from an infinite number of points in the sky, and cross and recross at an infinite number of angles; they fall on the floor and sides of the space, and reverberate, as it were, from every point at all angles. Hence there are within the space only very light shadows, and it is this absence of deep shadows which gives daylight its value, and should be imitated in artificial illumination. Again, just as it is impossible to see anything but the sun when looking towards it, so it is in a lesser degree difficult to see the objects in a space if the light which illuminates them is itself visible. The eye being prepared for the stronger rays coming from the light itself, is unable to take in the lesser rays reflected from objects.

The foregoing laws enable us to say there will be loss:—

1. When the rays are altogether stopped.
2. Whenever deflected rays are substituted for direct ones.
3. Whenever there is undue concentration of light in one source.
4. Whenever the source of light is too far removed from the objects to be illuminated.
5. Whenever concentration of the rays is substituted for diffusion.
6. Whenever the lights are so placed as to dazzle the eye.

Of course it is not possible to avoid these sources of loss entirely; the point to note is that every avoidance is an economy, and every non-avoidance a waste. Let us therefore examine the system of interior candle lighting now in use, to ascertain how far it offends against or fulfils the conditions prescribed.

This system consists of seven lanterns, or arrangements for displaying light.

1. The Police Lantern.
2. The Wing ,,
3. The Fighting ,,
4. The Magazine Light.
5. The Hand Lantern.
6. The Mess Sconce.
7. The Office Bracket.

Taking first the loss arising from entire stoppage and deflection of the rays, we shall observe that the three first lanterns in this list offend most seriously; the remainder do not require notice on this head. In Figs. 3 and 4 are given sections of the Police lantern, showing what light comes out direct, what comes out reflected, and what never comes out or is used at all. Considering the source of light as 1, we find it thus disposed of:—

Lost in the lantern	0·40
Reflected rays	0·25
Direct rays	0·35
Total	1·00

Thus only six-tenths of the light can escape from the lantern to do its duty of illumination: but even this is an over-statement. The best silvered lighthouse-reflectors absorb one-half of the light falling on them; silvered reflectors in ordinary use afloat do not absorb less than three-fourths of the light falling on them; the reflected light escaping from the lantern is thus only (say) ·07. That is to say, ·42 only of the whole light produced in the Police lantern is available for illuminating the decks.

In Figs. 5 and 6 are given similar sections of the Wing and Store-room lantern, which shows the following results:—

Lost in the lantern	0·56
Reflected rays	0·10
Direct rays	0·34
Total	1·00

Leaving, according to the estimated value of the reflected rays, only 0·37 of the light produced available for illuminating. There is, however, in this case a further loss, in consequence of the reflector being so constructed as to reflect most rays from two or three surfaces before they are suffered to escape, a loss taking place on each reflection.

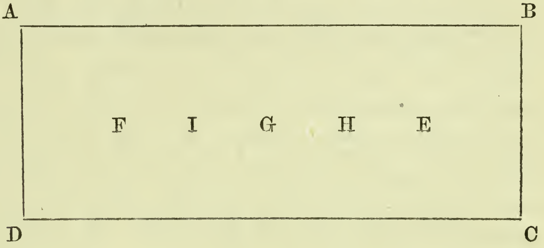
In Figs. 7 and 8 are shown sections of the Fighting lantern, whose light is thus distributed:—

Lost in the lantern	0·65
Reflected rays	0·15
Direct rays	0·20
Total	1·00

According to the estimated value of reflected rays, it will be seen that ·24 only of all the light produced in this lantern comes out of it to illuminate the deck, and even this allowance for reflected light is much too great, owing to the elaborately improper construction of the reflector. It is so arranged that many rays are reflected as much as four times before they are finally allowed to escape, so that even were the surfaces of the finest polished silver, such escaped rays would only possess one-eighth of the power with which they originally left the flame. The exceedingly small amount of available light from these lanterns is patent to anyone who has seen the decks of a broadside ship lighted-up for action. The want of light is then very marked.

If we apply the foregoing figures to the expenditure of such a ship as the "Monarch," we shall get some idea of the loss sustained by a defective system of lighting. She shows a yearly expenditure in the police and wing candles of £315, out of which no less than £168 appears as lost in the lanterns. If we applied the loss so calculated to the whole expenditure of these candles in the Navy, we should obtain a total loss of £7,400 a-year.

The next consideration is the position of the lights in the spaces to be illuminated, and brings us to the losses consequent on undue concentration in one spot; removal of the light too far from the objects to be illuminated; compression of rays in lieu of diffusion.



If A, B, C, D, represent the plan of a space to be illuminated, such as one side of the deck or a compartment, it would, under the existing system, be lighted either by one police light at E, or by two wing lights at E and F. Assuming that no rays are lost either in the lanterns or by reflection, and that when lights at both E and F are used, they are each half the power of that used as a single light at E; we must enquire under which of the two methods such a space would be best illuminated. If we suppose the light from the single source at E to be equal to 2 at G, the centre of the space, it will only be equal to 0·5 at F.; but if two lights, each equal to half the single light, were placed at E and F, there would be at G twice the light of 1 or 2, the same as before. Yet this would be the least light in any part of the space. Hence we see that there is a real loss wherever one large source is substituted for two small ones, and that nothing but practical considerations should limit the sub-division of the light into numerous sources.

We have seen that a light at E and another at F will better illuminate the space A, B, C, D than a single light of twice the power of either, at E. It must now be observed that these lights were as far removed as possible from any objects to be illuminated within the space, and that some light would be gained were they not so far removed, but this involves the question of reflection.

If reflection were perfect, half the light of the single source at E would be reflected towards F, so that the removal of the reflector would diminish the light at F to ·25, and at G to 1. If the light were now moved to the central point, G, there would be the light of 1 at E and F, and no less light in any other part. Hence we may say that bringing a light from the extreme to the centre of a space to be illuminated, doubles the minimum light when reflection is perfect. As, however, one-half at least of the light is lost in reflection, it follows that one-fourth only of the whole light reaching F from E would be reflected. Hence the removal of the light at E to G would give 1·5 light to F,—three times what it had before. Placing the light centrally, therefore, really trebles the minimum light in the space.

By again subdividing the single light at G into two half-power lights placed at H and I, two points such that the light at G from the equadistant lights shall be equal to the light at E and F, we should still get better illumination than from the single light at G, for when the lights were as far off G as E and F, without reflectors, the light at G was equal to 1·5, and now that they are nearer the light, must be more than 1·5, which is also the state of the case at E and F, so that by abolishing reflection and distributing the light into two sources at H and I, we actually multiply the minimum light by more than three. We see, therefore, that even allowing the possibility of making reflected rays as powerful as direct ones, which cannot be done, the worst way in which we could go to work to light the space A, B, C, D, would be to place a single light at one end of it. The next best way would be to place two lights of half power at each end, and this would be nearly equal to putting a single light of full power in the centre. The best way would be to put two lights of half power at H and I. As, however, the two latter plans use direct, instead of reflected rays, they are both very much better than the two former.

In undue compression of rays the police lantern, and the magazine-lamp, stand pre-eminent. A reference to Figs. 3 and 4 shows how the reflected rays issue from the police lantern in nearly parallel lines, instead of radiating as the direct rays do. The light is taken away entirely from one part of the space and given entirely to another part, when both parts require an equal half share of it; the consequence is the often observed failure of the police lantern to give light into the ship's sides, and the deep shadows thrown by it.

The small amount of light in our magazine and shell rooms is often complained of, and yet the quantity and size of the candles employed to light those very small spaces is disproportionately great.

The explanation is that some serious sins are committed against the primary laws of light. In Fig. 9 is given a section of this lighting arrangement. It will be seen that the form of the reflector has no relation to its intended duty, even supposing its surface was moderately reflective, which it is not. The direct rays radiating naturally, fall upon an enormously thick lens, in which they leave behind much of their original power. They are, by means of this lens, diverted from their radial and proper course, and compressed into a bundle of rays which pass by the sides of the passage and heads of the powder cases, and illuminate either the end of the passage or the men at work in it.

Besides this, only about one-fifteenth of the light produced finds its way into the magazine, the remainder being wasted in the light rooms. It is quite possible to deal with from one-third to one-half the light produced, and thus a source of light of one-fifth to one-seventh the power of those now used, ought to illuminate as well.

When we thus pronounce against the system of lighting the decks and magazines, we must not omit to qualify our dispraise. The police lantern was designed for an Argand oil-lamp of six to eight candle-power. Such a lamp could not well be divided into several sources, and, owing to the cheapness of the light, a large waste was allowable, being balanced by other conveniences. Besides this, the police lamp was intended to illuminate long stretches of deck; and though its design could, no doubt, have been improved, all that is now counted for loss in a short compartment illuminated by candles, could not be so counted on a long deck illuminated by oil.

So also with the magazine arrangement. The passages being narrow, and compulsorily lighted from the ends, some compression of rays is desirable, but it is better that the compression should deal only with the reflected rays, leaving the direct ones to flow out radially in their full power.

We have lastly to consider the loss of produced light consequent on so placing the source as to meet the eye, and prevent its appreciating any less light from objects. This loss may be dismissed with the remark that, wherever light emanates from a point below the ordinary plane of vision, we suffer from this loss in a greater or less degree. How much, cannot be determined as a principle, but must be referred to each particular case as it arises; and they are constant on board our ships.

None of the lanterns at present in use are so made that they can be easily cleaned, and we all know the labour and time occupied in making them even decently presentable. They are all cheap in price, but are of inferior workmanship, and not calculated to last any time. Being generally made of tin, they are very liable to injury, and when injured, are valueless.

The variety of candles in use adds considerably to the clerical labour both afloat and at the Admiralty, besides all the inconveniences of proportionate supply of each kind; and is not improbably a direct source of expenditure in itself.

Having now roughly weighed all the foregoing points, and having examined closely such of them as appeared to require it, we are able to plan out what the nature of the reform should be, and what directions it should take in order to be efficient. The heads of the problem stand thus:—

1. To reduce the varieties of candles to one, or at most, two kinds.
2. To improve the tubes so as to reduce the loss in burning.
3. To design lanterns for lighting the decks and magazines, which should allow all possible light to pass out of them; which should use as little reflection as practicable, and to place them as much in accordance with theoretical principles, as the conditions of a ship will allow.

4. To construct the lanterns so that they may be lasting, and not liable to injury; valuable even when useless as lanterns; easily cleaned; and simple in character.
5. To arrange such a system of security as may, without complication, prevent fixed lights being tampered with.

In determining the sort of candle or candles, if two varieties are retained, which ought to be adopted, we have to consider that the same candles must perform a great variety of functions. They must answer for seamen's messes, hand lanterns, permanent lights on decks, the special lighting of troop-ships, signal lanterns, and, if possible, top, stern, bow, and mast-head lights; the first functions on the list requiring a weak, small light, and the latter the most powerful obtainable. But an expensive, powerful candle would not be available in messes, &c.; while it may be possible so to develop the light of a weak one, as to make it perfectly fulfil the offices of a strong light for signal purposes. We must therefore adopt for all purposes a candle of a power not greatly exceeding the smallest now employed.

I need not detail the experiments that have been made in order to secure an efficient candle for general purposes, nor the variety of substances and the make of candle, rejected after trial; it is enough to say that we finally chose for substance, a hard stearine of a light-brown colour, and of dimensions arrived at by experiment as calculated to fulfil the object. The particulars of the candle are given below:—

Substance	Light-brown stearine
Price per lb.	8½*d.*
Length	3·7 inches
Diameter	1·2 ,,
Weight	1,040 grains (about 7 to the lb.)
Wick..	42 threads
Melting point	127°
Consumption per hour ..	130 grains
Light.. .. .. .. =	1·1 standard candles
Duration	8 hours
Cost per hour	·157*d.*
Figure of merit..	7·0

This candle which is called the Deck Candle, and which was prepared by Messrs. J. C. and J. Field and Son, of Lambeth, at 8½*d.* per lb., gives a light which is rather more economical than the present Eight, still more economical than the present Twenty-four, and considerably more economical than the present Signal candle. On the other hand, it is less economical than the present Police candle, and considerably less economical than the present Fighting candle.

The candle being fixed on, the next point to consider is the method of burning it. This it is proposed to do entirely in tubes of a uniform pattern, so that any tube will fit any lantern. The loss from failure of the tube to do its duty, adverted to before, it is proposed to remedy as has been mentioned.

The next point is, a reflective surface. Silver has quite proved its incompetency; but the difficulty has been to replace it. Just at the time I wanted it, a Company started in Birmingham and in London with a new process of plating with nickel. This metal takes nearly as high a polish as silver, with the advantage of retaining it. It does not tarnish, is nearly as hard as iron, and requires very little trouble to keep it bright. I have had two reflectors, made a year ago, lying about exposed as they would be afloat, as a matter of experiment. One is of silver and the other of nickel. The former is black, discoloured, and has nearly lost its reflective power; the other is almost as bright as when it reached my hands; neither have been washed. Were we to get nothing but nickel reflectors out of the revision of the system of lighting in the Navy, it would be a great step in advance.

We now come to the employment of the deck-candle for the permanent illumination of the decks, wings, compartments, &c., as to which the following general remarks must be made. We have seen that for the illumination of a space, such as one side of a deck, there is no more wasteful or less efficient method than that at present in use in our ships, namely, a single large light placed at one end of the space; that the next best plan was dividing the large light at one end into two of half the power, and placing one at each end, a method nearly equivalent to putting a single light in the centre; but that the best method of all would be to place two lights of half power in positions equivalent to H and I in the figure.

It happens that this falls in with the other requirements. Central lights must be placed overhead, consequently all the direct rays it is possible to employ are available, and those which would be lost amongst the beams can be reflected downwards, and so saved.

The "Deck Light," as it has been named, is designed on these principles, and if all goes well, it is hoped it may become the chief instrument for lighting the Navy. In parts it is as nearly perfect as such a thing can be, but it yet remains to be seen how it will answer afloat.

A reference to Figs. 10 and 11 will show that nearly every ray is employed in illuminating—every ray, in fact, which can be employed, and the calculation is that while the light of the present police lantern only gives 1·29 candle power for illuminating, out of a production of more than 3 candles, the deck light will give ·8 candle power out of a production of 1·1. Two deck lights on this calculation are more than equal to one police light, but three can be employed without increasing the expenditure, A ship like the "Monarch" would take about thirty of these lanterns.

The objections to this overhead system rise to one's mind at once. How is sufficient height to be obtained under the lanterns, and will not the hammocks obstruct the light? As to the first point, the full advantage of the light is obtained when the bottom of the lantern is 8 inches below the beams. This leaves ample space in most parts of the iron-clads. Where there is not space, the lantern may be carried rather higher without much loss. Generally speaking, however, the lights should be placed out of the traffic, over bitts, pumps, hatchways, &c., or guarded by stanchions.

As to the hammocks, nothing short of complete trial will show how they affect the question, but remembering the value given to the rays of a light whose source is concealed, I am of opinion that the hammocks will interfere much less than might be thought, and certainly in no way to obstruct the light. The lamps must, however, be always hung where the clews cross.

In some spaces, however, overhead deck-lights cannot be used. Then the improved wing-light (Figs. 12 and 13) comes into play. Much less light is lost here than in the present wing, but otherwise it performs the same office.

In order to obtain security for these permanent lights, an arrangement called a locking staple has been designed. It is so planned, that placing the lantern in position locks it there, and then neither candle nor lantern can be removed without the key.

In lighting the decks for fighting purposes, it is hoped an extra supply of deck lights will do all that is necessary, but this cannot be spoken of with certainty, as there is some doubt whether they will stand the vicinity of the modern explosions. If they will not, an improved fighting lantern must be constructed.

Were it not for uniformity, the only change proposed in the magazines would have been the substitution of plane glass for the lens, and proper reflectors. With the deck-candle and a proper reflector, combined with the plane glass, we ought to get a better light, although not, perhaps, very much better.

It has always appeared to me that our ships' companies' messes might be better lighted than they are. The authorised lighting for a mess is now 2 "Twenty-fours" in summer, and 4 in winter, an average of 3 all the year round. In many ships it is now the custom to supply messes with wing-lanterns and fighting candles. In one case the nominal supply is 4·4 to 8·8 hours light of 1-candle power. Practically it is much less, as we have seen. When supplied with "fighting candles," a mess gets 14·7 hours 1·6 candle light. A mess table 12 feet long cannot be said to be well lighted with 2 candles, unless some care is taken not to waste the light. A trial is therefore to be made of the mess light (Fig. 15). This is, like the deck light, intended to utilise the rays flowing upwards from the light, by turning them downwards on the table. Seamen are not easy to arrange for in matters of comfort, and have their own ways of looking at things, but I hope this plan won't give them any more trouble, but will give them a good deal more light.

The commonest and simplest-looking of all the lights in use is, perhaps, the most difficult to deal with. The existing "hand-lantern" is an object of abhorrence to me, and to, I suppose, most Naval Officers. It is always dingy, difficult to keep clean, and usually will not stay alight in a breeze. The glasses are always broken, and on foreign stations, wood or tin takes the place of glass, so that the use of a lantern becomes rather a matter of form. We have made an attempt to use talc in lieu of glass in a very much stronger lantern, but it remains to be seen how it will answer (Fig. 16).

The lighting of the engine rooms does not demand much notice here. In principle it does not show the defects already alluded to. Overhead central lighting is generally used when it is possible, and the defects—many, it must be confessed—consist of small details without connection, and to be combatted separately.

There are now 7 kinds of lights used in our engine-rooms, 1 overhead hanging, 2 side, 1 gauge lamp, fixed, 2 hand lamps, and a safety lamp, for use in the coal bunkers. The latter is very inefficient, but it is not easy to provide a substitute. I am making an attempt to abolish chimneys—a source of much trouble—and to introduce a universal wick. The latter may certainly be done to a great extent. Nickel will here also come into play for reflection, and give increased light.

Turning to the lights for exterior use, I may take the signal-light (Fig. 17), first, as the principles introduced in it will probably be carried out in every other. Hitherto it has only been attempted to bend the rays of exterior lights in ships by simple refraction. As a ray of light cannot be so bent in a single glass lens more than 41° 49′, it follows there is theoretically an arc of 96° 42′ above and below the horizontal plane of the light which has hitherto been wasted. Practically the arc is much larger. Very few lenses are made according to rule, and the notion of a focal distance is commonly disregarded in placing the light within them. By attending to these points, I think we have a really good signal lantern, and may get really good "bow," "mast-head," "top," and "stern" lights. The plan adopted is a very simple modification of the designs of Mr. Stevenson, the engineer to the Northern Commissioners of Lighthouses, and which he called the "Holophotal System," in consequence of its using all the light possible. The lens consists of a central plano-convex part, and two bands of plane glass above and below it. All the rays that can be refracted horizontally are dealt with by the plano-convex part. Those which pass immediately above or below, go through the plane part of the lens, and are reflected horizontally, from a polished nickel surface outside the lens. Those which pass away at a still greater angle, are reflected from surfaces inside the lens, and pass out horizontally as reflected rays through the upper and lower plane bands. We thus have a central band of refracted light, and two bands of reflected light above and below. If all were perfect we should be compressing light radiating 180° into a band radiating (say) 10°, thus multiplying the power by 18. As it is there is considerably more divergence, and great absorption of rays in process of bending. With all this, however, we get out of the deck candle—the least powerful candle which has ever been used in a signal lantern—a penetration greater than any signal light we have yet had in general use.

Very great importance is justly attached to the "bow" and "masthead" lights. Those now established in the Navy are about the best I have seen, although the custom of employing paraffin increases the power of even inferior lanterns used in the mercantile Marine. Yet our lights only just fulfil the requirements of the law when the oil wicks are in perfect order, and do not fulfil them when using candles. The source of light with oil is from $4\frac{1}{2}$ to $5\frac{1}{2}$-candle power, while, as I before noticed, the largest candle made is only a little over 3-candle power. It may be possible by the use of the "holophotal system," to get out of a single candle sufficient power; that remains to be seen. And here I will show an experimental "bow-light" which I have tried, with the view of employing the deck candle. In this case two candles are used, and by means of nickel reflectors, the light from each is concentrated into a beam, having a divergence of 6 points. The two beams are then made to overlap one point, so that horizontally the arc illuminated is 10 points, while the vertical divergence is 6 points. On trial with white glass, this arrangement has been found about equal to the Government "masthead" when burning candle, but inferior when burning oil. This agrees with the theoretical estimate, and it would appear that three deck candles so treated, would beat our present patterns completely, and give us the desideratum of bow and masthead lights, with the permanent light of candles, in lieu of the fitful light of oil. I should mention that with colour the catoptric light has totally failed, but this is only an illustration of the difficulties presented by colour. As yet no standard of measurement has been established for the shade or density of coloured glass, and a difference of tint, hardly appreciable to the eye in daylight, will immensely alter the penetration of the light through it at night. After collecting all the information I can on the matter, I am driven to a course of experiment on the penetration of coloured rays, from which, after all, I do not hope for more than some rude guide, sufficient for the practical circumstances of the case. I am also constructing a holophotal "bow" and "masthead-light" (Fig. 19), in which, having compressed the direct rays into a diverging beam of about 10° by refraction and reflection, as in the "signal-lantern," the back rays are reflected side by side with the direct. Then in the case of the bow lights, as the light is only required over a horizontal arc of 112° 30′, the light passing beyond that is reflected by means of nickel reflectors into that angle. In theory this arrangement multiplies the source of light by about 22, practically much less.

No doubt with a special candle such plans will give us, when perfect, very excellent "bow," "masthead," and other lights, but the process of arriving at perfection is tedious in all cases, and in my experience in nothing more tedious than the lighting of Her Majesty's ships.

Commander Gilmore, R.N.: I wish to remark that the direct light must always be the same in power: you cannot increase it, neither can you reduce it by refraction or reflection. (Captain Colomb: You can reduce it.) You cannot reduce the direct light. The horizontal light must be the same, whether you apply refraction or reflection to it; you cannot take it away from itself. In the "Revenge" we had lights like that of the ordinary police-lamp. I put wings or flanges on the top of the two sides, bent up and slightly curved down afterwards. I tried them with the photometer; the refracted light was exactly the same, the reflected light was very much increased. As regards the expenditure on board ship, we all know that quartermasters have their pull of the candles that are left. That is not the measure of the loss by candles. Captain Colomb mentioned a patent lock of his. Three years ago I submitted to the Admiralty a lamp which it would be perfectly impossible for any man to open without extinguishing it on the spot. There is no lock to the lamp. It locks itself in the act of closing, and puts itself on a hair trigger; the very first time you touch the lamp to open it, down comes the extinguisher, and out goes the lamp. I proposed to the Admiralty to apply it to lamps in magazines, indeed anywhere where there was danger attending the use of lights. The Admiralty, however, have not accepted my proposal.

Captain Burgess: I should like to ask, whether you have any particular rules with regard to the admission of air to the flame in the various lamps you have mentioned.

Commander Boyle, R.N.: There is one thing I should like Captain Colomb to consider. No doubt he has done so. But as one who has had opportunities of judging of the practical working of ships' lamps for the last three years, I know perfectly well what the general opinion of the service in the matter of lighting is. As a rule when you commission a ship there is no "lamp-trimmer," and there is a great difficulty in getting one. Sometimes you get a man off from the shore who says he is qualified for the post. You ask him what his qualifications are, where he picked up his business, and you find probably that he has followed the plough as an introductory preparation for a lamp trimmer. He goes down and prepares himself, and after about six months he has got into the way of scrubbing the reflectors with such energy that he has got all the silver off. That is one of the main points which I think must be corrected before any system of lighting can be really efficient in the service. Then, there is another thing which will have to be considered. Of course Captain Colomb has considered it. He talks of lighting the area in the ironclad ships, but there are so many holes and corners, and it is just those holes and corners that require lighting up. If you put a light into the middle of a flat, the rays will not penetrate into the parts where you want the light to show. Therefore, the light at the end, which, though it may not contribute a greater or equal lighting power, will yet be more efficient, because it will show into more parts. Then, again, with regard to the "fighting-lantern," that is one of the most glaring things in our service. Anybody seeing a ship supposed to be lighted up for battle at night, for the first five or ten minutes may well laugh; just for the first moments when the lamps are lighted the flame burns pretty vividly, that is, if you have a good gunner who has looked out and put some spirits on the wick. But directly after that, before the wax begins to melt, there is a general "dim religious light," while everybody is waiting for the flame to burn up again before they can see to do their work. Of course that will be corrected under the new system. Further, anybody who came here to-night with the idea that there was nothing to learn from lighting a ship, may well see that he is very greatly mistaken. I have learned more than I ever thought it was possible, and I know there is a great deal more in the system which I have yet to learn, and which I shall be very glad to learn.

Commander H. W. Brent, R.N.: I should like to ask Captain Colomb whether in the "bow-light" he has there in the two lanterns, there is not a point close to the ship, which would be four points on the bow, almost in darkness? Looking at it as it is there, it seems to me that though the rays cross by that division between the two lights, close to the ship, and even some distance from the ship, there will be a point of great darkness.

The Chairman: I should like to ask whether the reason why the old reflector was broken up into so many different parts was not that the rays were bent, and they could not pass through the candle so as to melt it; and whether, if it does pass the reflected rays through the light, it incurs any risk of heating the tube which contains the candle, and melting the candle more rapidly than it otherwise would melt?

Commander W. Dawson, R.N.: It is so long since I, an old retired Officer, have had anything to do with the Navy, that I suppose many things have changed since those "good old times," for in those "good old times" we did not wish for any light, either moral or material. Now, it seems, there is a general wish for both, and, since darkness, moral, mental, and material has been abandoned, things seem to have changed very much. In those days there used to be a hand-lantern something like the one on the table. I remember that they used every night to serve out several candles with each lantern. One candle used to be stuck in the socket for lighting, and the other four or five were placed in the bottom of the lantern, as a sort of store. It happened on one occasion—indeed I suppose it happened more than once—but on one of the occasions when the lighted candle burned down rather too far in the socket, and set fire to all the spare candles stored in the lantern, the ship was set on fire. It happened in a store room, near the magazine, and but for its accidental discovery, the consequences might have been very serious. It would then be a very good thing if we could get rid of the necessity of issuing an extra supply of candles, by employing one large candle to do the work of half-a-dozen small "twenty-fours." In my days we had also great difficulty in keeping these hand-lanterns in order, as they necessarily got knocked about and injured very materially. My experience agrees, therefore with Captain Colomb's in the East Indies, as to the difficulty of keeping those hand-lanterns in repair, and I shall be very glad to hear that substantial and safe hand-lanterns are supplied. As to the police lamp, my recollection is that the light used to be concentrated along the centre or clear part of the deck, whilst the messes and midship parts were quite in darkness, so that evil disposed persons might do what they liked in the messes unseen by the police. So far from being a police light, it was rather a rogue's light. If the principle, which Captain Colomb has explained to us, of dispersing the rays through the compartments were carried out, it would meet that difficulty better than the present police light. But I am not quite sure, looking over some of our present ironclads, that there would not be some difficulty about suspended lamps throwing their light below the hammocks, as the hammocks hang in some ships very far below the beams. It may be found necessary to suspend these lamps a little more below the beams than Captain Colomb at present contemplates. The magazine light was always a great nuisance to gunners, and was so shamefully placed that it gave rise at times to very great dangers. The light was concentrated entirely on one spot in the magazine, where it was not wanted, and all the rest of the magazine was in darkness. When there were half-a-dozen men in the magazine passage, the first thing was for one man to get between the light and every one else, therefore everybody in that passage but that one man worked in darkness. In emergencies it became necessary to run great risks, and to do things contrary to the regulations, the difficulty being got over by taking lanterns into the magazine itself. I have seen that done repeatedly when the exigencies of the service required it, because the lights supplied to the magazine were useless. Officers ought not to be placed in a position to incur such a serious responsibility, and involving such serious risk. Although Captain Colomb disperses the light over the passages, and has thus worked an immense improvement, he does not get over the difficulty of a man getting between the light and his comrades. It was suggested some years ago, by Lord Lauderdale, I believe, to take example from the way in which railway carriages are lighted, and to light the magazine from the roof. That would certainly overcome the difficulty I allude to, and it might be possible to do so without very great danger. Whatever little danger there may be from lighting from above would be less than the danger which now exists from being occasionally compelled to take lanterns into the magazine itself. I do not know that there is any other lantern that calls for remark from me, but I quite agree with Captain Boyle that we have learned an immense deal to-night, and I think that there is a great deal more that might be learned from Captain Colomb on the subject of lighting. I would venture to suggest that it would be a capital thing for the service if Captain Colomb were to bring out a little handbock showing, in a small condensed form, how lanterns should be managed, and the principles on which they are constructed. Such a handbook would be of great use to Officers as well as to lamp-trimmers.

Captain COLOMB : With reference to the lock, some kind of lock is necessary. The custom is to supply police and other lanterns with padlocks, but the locks disappear the first day after they come on board ship.

Captain GILMORE : But my lamp is its own lock. As you close it you lock it, you put it upon a hair trigger, and on any attempt to open the lamp you touch the small trigger, down comes the extinguisher, and out goes the lamp.

Captain COLOMB : The only objection to that is that you do not always want to put the light out. The admission of air that Captain Burgess spoke about, is a *bête noire* to anybody that has to do with lights. There are no known laws, and you can get no information in the trade. The lamp-makers have no rules whatever. Every separate lamp is a matter of experiment. But, generally speaking, I have found clearly enough that the upper exit for the air in lamps is a great deal too large, and the entrance for air below a great deal too small. It is the cause of much of the smoke which is complained of now. For instance, in the troop ships they have great difficulty in keeping the cabins and saloons clear of smoke from their candles ; it is a perfect nuisance to them. One of the reasons for that smoke is, simply, that the entrance for air in the lamps is too small, and the exit is too large. The consequence is that the air, instead of flowing upwards to the flame, flows upwards and downward in two currents from the open space above, and there is a perpetual struggle going on between those two currents; combustion is checked by the change of current, and smoke is produced. To avoid this, you must make your exit for the flame so small, that there can be no down current. But, then, the moment you have done that, you come to another great difficulty, viz., the exhaustion of the air below. Any current passing under this lamp, as it stands now, even a very slight current, exhausts the air so much that out goes the light. There is great difficulty in guarding against that. The only plan known is to put something, in the nature of a break below, so that the air, instead of passing clear across, shall strike some surface, and a part of it shall be driven up, and a part of it down. There are no rules about it. The signal lantern will take its air entirely from above. The holes are placed round the top, and then the air supplied to the flame comes down between the lens and the inner reflector, in a thin film. The exit there is in the centre.

Captain BURGESS: Have you not noticed in all the new oil lamps that there are a great many more perforations for the air to come in at than there are in the old lamps? Honey, in Regent-street, has a large collection of these lamps, which give an intense light, but they require chimneys.

Captain COLOMB: I have not noticed that. There is no doubt whatever that the exit at the top must always be very much smaller than the entrance at the bottom; but, generally speaking, it is the other way. But for lamps which have to be exposed to currents of air, such as signal lamps, I find the best way is to let the exit and extrance be close to one another; then the same current, instead of struggling in the lamp, is divided outside it, one half goes down to feed the flame, and the other half passes across the top, and forms an exhaust.

The CHAIRMAN: Will that lamp stand a gale of wind?

Captain COLOMB: As it stands now, it will go out the moment you take it into the air.

Captain GILMORE: The feature of my lamp is a cone; the air comes from three tubes round it. The oxygen is taken in over the solid cone, and it will stand any amount of draught.

Captain COLOMB: There are an infinite number of plans. The difficulty is to get at the principle, and there is none established. Captain Boyle spoke with reference to the lamp-trimmer. I perfectly agree with him, that we ought to have a better class of lamp-trimmers. Lighting is a most important thing in all our ships; we ought to have properly appointed people to look after it. But my view as to these matters is, we must not take things as they ought to be, but as they are. So the object in all these plans has been that the lamp-trimmers shall have less trouble, and shall have less to do. It will be more difficult for a man to go wrong if you extend the hours of burning the candle from seven hours to eight hours, making it a measure of the twenty-four. We suppose the number of his journeys will be limited, and that he will be able to go through his work in one journey, instead of making two or three. Then, by giving uniform tubes, every tube fitting the lanterns, he can take his round with the new tube and go on. Generally, the lamps are so made, that the amount of cleaning required is very small. We tried to make them of the simplest possible character, so that let the lamp-trimmer be what he will, he cannot very well make a mistake. With regard to the broken up spaces below, I think Captain Boyle states what is exactly right. The ironclads are particularly difficult to light, from the immense amount of broken up space below. But I think by the over-head system, and by using numerous lights and small sources of light, we are much more likely to overcome that difficulty than by using large sources of light; because, after all, this is a question of money. The reasons why our ships have not more light than they have now, is simply the cost. The cost of candles at the present time is about £30,000 a-year, and it is a cost which is continually increasing. Now, the calculation on the whole of this is, in the "Monarch"—and it is borne out in the "Hercules" and the "Sultan," as fairly as one can judge—that, at least one-third of the cost of the candles for those ships may be saved, while the ships themselves will be much better lighted. But if not better lighted, we can give them one-third more light than is now allowed them, without calling upon Government for more money. What we have really done is to spend upon lanterns and so save upon candles. The whole of these lanterns cost from two to three times what the old ones do. The Admiralty seems to admit the reasonableness of providing strong things for the Navy, although they cost more at first. But then the calculations are based on a year's expenditure in the "Monarch," and with the new lighting she provides herself with new lanterns throughout, and saves £160 on the year, owing to the saving in the candles. Captain Brent asked with reference to the crossing of the light. The light here crosses 3 feet from the lantern; but owing to dealing with a thing of the size of a flame, and not a mathematical point, the light becomes dim at some little distance beyond that. It is a light that would show 10 or 12 feet off, and it would always be a pretty bright light. We have tested this light at a range of half a mile, a mile, and a mile and a half, and running through the whole arc of the five points. It is not perfect, still it does give a fair white light over that arc. Dim certainly towards the point right ahead, and dim a little just at the centre point. But that is all to be got over. Supposing this form of arrangement were decided upon, we should simply use three candles instead of two, and compress the rays of each candle still more. Here, we compress the rays of each into twelve points; there we compress them into seven, and of course get a very much greater power of light.

The Chairman: With the coloured glass?

Captain Colomb: With the coloured glass. I am going to carry out a number of experiments with coloured glass, both green and red. I should put the coloured glass in each bull's eye, and not as a shade before the bar. There is little, however, known about coloured glass; there is no standard. I have consulted Professor Tyndall about it, and he informs me that there is nothing authoritative on the subject. The Chairman asked some question about reflectors.

The Chairman: The broken reflectors in the original lamps;—was not the object to avoid sending the rays through the candle?

Captain Colomb: I do not know. I think it was done, in accordance with a notion that I find many people have, that in some kind of way the reflector generates light. But there is a difficulty such as you have mentioned about the increase of heat. I found it in the deck light. At first I sent the rays through the light; it did not destroy the wick, but I found the heat generated was extreme. Captain Dawson spoke of the hand-lanterns burning up. I have seen precisely the same thing. They carry a two hours' light, and they are sometimes further supplied with seven or eight hours' supply in the lantern, having no other place to carry it in. The lantern tumbles, and the whole of the candles and lamp burn together. That I have often seen. About the overhead light in the magazines, I quite agree with Captain Dawson; the proper way to light the magazines is overhead. But as far as I know there are difficulties in the way. Captain Harris can corroborate me, as we have gone into that matter in the "Sultan" and "Hercules;" and at any rate in existing ships there are these difficulties.

Captain Gilmore: The great objection is that the rays of the magazine light being concentrated on one spot, one man standing before the light throws the whole place into darkness.

Captain Colomb: A great deal of that difficulty is got over by doing away with the bull's eye lens, the rays being allowed to flow out radially, they cross and recross in all directions, so that the actual amount of light in the passage is greater, though the source is small.

The Chairman: You will allow me to return your thanks to Captain Colomb for his very valuable paper, in fact, the whole service is indebted to him for the great pains he has taken on this subject. We shall all benefit by it.

LECTURE.

Friday, June 7th, 1872.

Colonel P. J. YORKE, F.R.S., Vice-President, in the Chair.

ON EXPLOSIVE AGENTS APPLICABLE TO NAVAL AND MILITARY USES, AS SUBSTITUTES FOR GUNPOWDER.

By F. A. Abel, F.R.S., Treas. C.S.

The possibility of replacing gunpowder, to any important extent, in its application to ordnance, by other explosive agents, appears at the present time as remote as it has been at any period during the history of gunpowder. No explosive mixture, or compound, for which special superiority has been claimed in point of power is so susceptible of regulation, or control, as gunpowder, with regard to the rapidity and violence of its action, even at a considerable sacrifice of the peculiar properties which are regarded as constituting points of superiority. Although very great advance has recently been made towards the attainment of control over the violence of action of gunpowder itself, when used in very large charges, it cannot yet be said that even with the most approved forms of powder which are now employed, the development of force in the largest guns is not occasionally unequal, uncertain, and intermittantly violent.

In guns of only small calibre it may, however, yet prove practicable to employ explosive agents other than gunpowder with good results, and possibly with certain special advantages. Some considerable progress was made about four years ago in the application of compressed gun-cotton to the production of cartridges for field guns, but the requisite uniformity of action, and freedom from liability to the development of injurious local pressures had not been secured when experiments in this direction were suspended, and no important attempt has since been made to replace gunpowder even in the smallest ordnance.

Partial success has, on many occasions, attended the employment, in small-arms, of explosive agents differing considerably in character from each other, but all of them more rapidly explosive, and therefore more violent, than gunpowder. The chief advantages claimed, and more or less established for some of these over gunpowder, were in all instances the production of comparatively little or no smoke, the reduction of fouling, and increased penetrative power with the employment of smaller charges. Diminution of recoil was also frequently insisted upon as an advantage, the fact being lost sight of that this result, arising out of the greater rapidity or suddenness of the explosion, must be attended by increased local strain upon the arm, and, therefore, might constitute a source of danger. Preparations of various kinds containing chlorate of potash, together with very readily oxidisable substances, such as Horsley's powder, white gunpowder, Hochstädter's and Reichm's paper cartridges, &c., form one class of substitutes for powder, upon the application of which to small arms much time and labour has been spent, even up to recent periods, but in no instance, even before the introduction of the breech-loading arms of precision now used in military service, was powder satisfactorily competed with in regard to uniformity and accuracy of shooting at different ranges, while the comparatively great destructive effect on the arm itself was generally more or less strikingly demonstrated during brief experience with these substances. Attempts to apply gun-cotton to small arms, which were made soon after its discovery by Schönbein, in 1846, were similarly attended by results more or less disastrous to the arms employed. Many years afterwards Baron von Lenk produced a gun-cotton cartridge composed of threads arranged in firmly-plaited layers upon a core of wood, which was considered in Austria to furnish promising results, but which did not attain any position as a safe and serviceable cartridge. The Gun-cotton Committee, soon after its appointment in 1864, acquired some experience, especially through one of their members, General Hay, with several modifications of the Austrian small arm cartridge, in some of which a part of the gun-cotton charge was highly compressed in small cylinders, the remainder being in a highly inflammable condition; nothing conclusive of a favourable nature was, however, attained, though General Hay expressed himself confident as to the very promising nature of some of the results.

The reduction of the gun-cotton fibre to a fine state of division, or pulp, soon afterwards afforded several more effective means of controling the rapidity of explosion of small charges. The uniform dilution of the gun-cotton with ordinary cotton was readily accomplished, and the most explosive form of gun-cotton could also be uniformly mixed with a less explosive or more moderate variety. Messrs. Prentice originally employed diluted gun-cotton prepared by the first of these methods, the mixture being converted into sheets of stout paper, which were cut into strips of a particular weight and rolled up. Cartridges thus produced were safe and effective, provided they fitted the arm properly; but although they were to some extent successful for sporting purposes, they were far too variable in the manner in which they ignited in the gun to afford any promise of success as military cartridges. Soon after the system was devised of producing homogeneous masses of compressed gun-cotton from the pulped material, a series of experiments was carried out at Woolwich with the Enfield rifle in the first instance, and subsequently with the Snider-Enfield. The gun-cotton cartridges employed consisted of small cylinders of the compressed material, either in its pure and most explosive condition, or mixed with some proportion of less explosive gun-cotton. Several series of good results were obtained, both with regard to velocity and uniformity, but the attainment of the same results on a repetition of the trials was uncertain. Subsequently, in 1868, a considerable improvement was made at Woolwich in regulating the explosion of a gun-cotton charge in a rifle, which consisted in impregnating the compressed charge uniformly with a small proportion of a perfectly inert substance, insufficient in quantity to affect the ultimate results furnished by the charge. This was accomplished by allowing the small cylinders of compressed material composing the charges to imbibe the requisite quantity of paraffin, stearine, or similar material, either in the form of solution, of which the solvent was afterwards evaporated, or in the melted condition, the cartridges being kept heated sufficiently long to allow a very small quantity of retarding agent to become uniformly disseminated throughout the mass. More concordant results were obtained with cartridges thus prepared than had previously been furnished by compressed gun-cotton modified in other ways, and in several instances targets were made, at 500 yards, with charges of from 26 to 30 grains, which compared very fairly with those furnished by the service ammunition. The experiments were, however, discontinued in 1868, and though the Committee on explosive substances were afterwards directed to resume the enquiry with special reference to the Martini-Henry rifle, other important work has hitherto prevented them from making more than a few preliminary experiments.

The construction of the most recent form of sporting cartridge made by Messrs. Prentice, was based upon the same principle; a slightly compressed charge, consisting of a mixture of the more and less explosive forms of gun-cotton, was impregnated with a very dilute solution of India-rubber. This substance, when deposited throughout the mass, upon evaporation of the solvent, operated like the paraffin, stearine, &c., in reducing the rapidity of explosion, and also in protecting the charge against deterioration by absorption of moisture. The principle of moderating the violence of action of gun-cotton by interposing inert, or less explosive, materials between its particles, has been carried to an extreme in the production, by Mr. Punshon, of a species of gunpowder, which consists of gun-cotton mixed with a considerable quantity of sugar and saltpetre. This mixture appears to have furnished favourable results in breech-loading small arms (with the employment of a considerably larger charge than has been used of gun-cotton to produce similar results); its uniformity of action, and its keeping qualities, when brought into competition with those of the present service small arm powder, have still to be established by thoroughly comparative experiments. The problem of producing a substitute for gunpowder for small arms, which will rival it in uniformity of range and accuracy of shooting, while retaining qualities of special value from a "service" point of view, is an exceedingly difficult one. If an explosive *compound* could be used in a fire-arm in its integrity, and under the conditions essential for the maximum development of its explosive force, uniformity of action would be at once secured; but the suddenness of the explosion of all *compounds* renders this impossible, hence means must be resorted to for retarding their action, and they become thereby reduced to the level of explosive mixtures, their perfection, in point of uniformity of action, depending upon the mechanical perfection of manufacture, which, in the case of small arms powder, has reached so high a point as not to be readily excelled by rival processes or products. Moreover, in reducing a violent explosive agent to a level with gunpowder in regard to the moderation of its action, some of its special qualities, which appear at first sight to give it decided advantages over powder, such as high penetrative power, great reduction in the amount of charge required, perfect freedom from fouling and smoke, must be sacrificed, at any rate in part, and thus the first promise of great superiority over gunpowder in small arms is scarcely ever likely to be fully fulfilled by an explosive agent of greater violence than gunpowder. Schulze's sawdust-powder, and Punshon's gun-cotton powder, in both of which the pyroxilin is considerably diluted, are analogous illustrations of the manner in which the special properties of a particular explosive compound are to a great extent sacrificed in the production of a comparatively controllable explosive agent for projectile purposes.

By providing the naval and military service with an explosive agent considerably more powerful than gunpowder, for employment in shells, it may be hoped to combine with the superior penetrative power of the Palliser small capacity shells or cored shot, the additional destructive power possessed by shells of very large capacity, and also to supply a formidable destructive agent applicable in special instances in common shells. The chief difficulty in selecting an explosive mixture or compound suitable for such purposes from amongst the numerous violent agents with which we are now acquainted, has arisen out of the liability of most of them to violent explosion if submitted to the concussion sustained by a shell upon the explosion of the charge used to propel it. The Austrians fired without accident small spherical shells charged with gun-cotton in the form of a plait, using comparatively low powder charges; and a similar satisfactory result was obtained by the Gun-cotton Committee in experiments with 13-inch mortars. But the more violent or sharper concussion to which the shells are submitted in the rifled guns of the service, determined their premature explosion on several occasions, with eminently destructive effects upon the guns from which it was attempted to fire them. Subsequently gun-cotton in another form, and even a preparation of gun-cotton and nitro-glycerine, called glyoxiline, were safely fired from field guns, and during the late Paris siege a shell charged with dynamite was propelled without accident; but it was considered by those entrusted in England with the investigation of this subject, that a sufficiently violent explosive material might probably be selected for very advantagous employment in shells without necessarily incurring any risk of accident due to premature explosions. A series of preliminary experiments was accordingly instituted, which resulted in the selection of a mixture of picrate of ammonia and saltpetre (termed "picric powder" by Mr. Abel), as a substance possessed apparently of sufficient violence of action, and at the same time exhibiting but very little, if any, more sensitiveness to explosion by friction or concussion than ordinary gunpowder. This mixture differs most importantly from that known as *poudre picrate*, which was experimented with in France a few years ago, and appears to have been used to some little extent by the Communists, and the manufacture of which in France was attended by more than one fearful accident. The picrate of potash, which forms the basis of the latter preparation, furnishes mixture with chlorate of potash and saltpetre, of a highly detonating character, which explodes violently when submitted to moderate friction and concussion, and which can only be manufactured with very special precautions. On the other hand, the mixture of picrate of ammonia and saltpetre, though very violent, and considerably more powerful, weight for weight, than gunpowder, remains passive when subjected to severe friction and percussion; a number of shells charged with it have been fired, without a single premature explosion from various guns, including the 9-inch gun, with a charge of 43 lbs. of R.L.G. powder. The fundamental substance in this "picric powder," called picric acid, is readily prepared at a moderate cost from a well-known and very abundant product of the distillation of coal tar, called *carbolic acid;* the powder has been proved by experimental manufacture on a considerable scale, to be readily and safely procurable by following the ordinary manufacturing operations in use at gunpowder works; and, in regard to keeping qualities, it has been proved certainly not inferior to gunpowder. Some preparations, both of gun-cotton and nitroglycerine, may perhaps prove to be safely applicable in shells, but neither of those substances are likely to furnish a material for shells so safe as picric powder; moreover, they might probably not prove in practice to be so generally efficient, inasmuch as excessive disruptive or disintegrating power may constitute a positive defect in some of the more important uses of a shell-charge.

It is in the application of explosive agents to military engineering operations and to purposes of submarine attack and defence, that the greatest progress has been made within the last six years. Gun-cotton was tried as a blasting agent in this country very soon after its discovery; and it was found so superior to gunpowder in power, that a demand for mining charges, manufactured by Messrs. Hall, at Faversham, had already arisen in 1847, and was rapidly increasing, when the production of gun-cotton in England was put a stop to by the explosion at Faversham in that year. Many explosive mixtures, of which chlorate of potash was generally a constituent, have been since proposed for use as mining and destructive agents; but no permanent position as a successful rival of gunpowder has been attained by any one of them. After the improvement which Baron von Lenk effected in the manufacture and application of gun-cotton, that substance was made the subject of extensive experiments in Austria, and it was shown, in an elaborate report prepared by the President of the Austrian Engineer Committee, Baron von Ebner, to be applicable, with decided advantage, to several military engineering purposes, provided it was employed in a particular form and under conditions favourable to the development of its explosive force. In 1864, when the manufacture of gun-cotton was resumed in England, the Government Committee on gun-cotton obtained results demonstrating the efficiency of the Austrian form of mining charges, as a blasting and quarrying agent, especially in hard rock; the material being employed in the same way as gunpowder. The mining charges were in the form of short pieces of a compact rope, having a central perforation; they weighed very much less, and occupied a somewhat smaller space than the powder-charge required to accomplish the same amount of work. Their employment was soon found in actual practice to present decided advantages, especially for underground work (on account of the absence of smoke); provided the rock was not very soft and was free from fissures. In submarine operations, the gun-cotton rope was proved to be very decidedly superior to gunpowder, if it was enclosed in receptacles of considerable strength; hence it was adopted by the Austrians as the explosive agent for the submarine mines which they applied to defensive purposes in their last war. But the circumstance that very strong confinement was indispensable for the proper development of its explosive force, rendered it an inconvenient and uncertain material for employment in hasty demolitions and in several other military engineering operations. Strong practical demonstration of this was furnished by the repeated failures which attended the attempts of the Royal Engineers to apply charges of Austrian gun-cotton rope in connection with the demolition of the works at Corfu in 1863; although the charges were supplied by the Austrian Government in strong cases, specially constructed for the purpose.

The considerable reduction in weight, and decided, though not great, reduction in volume, of a charge required to produce a given effect in destructive operations, constituted advantages which became much more prominent when the system of reducing gun-cotton to a finely divided state, and then converting it by powerful compression into very compact homogeneous masses, was carried into practical effect in 1867. The density of the gun-cotton rope corresponded to about 30 lbs. per cubic foot, while that of the compressed gun-cotton is at least 60 lbs. per cubic foot; this difference, and the solidity throughout of the compressed gun-cotton, led to a reduction of more than one-half in the space occupied by a given weight; hence in mining and quarrying, the blast-holes could be greatly reduced in length and diameter, or a considerably larger amount of tamping could be used; and they could be placed at greater distances apart. Moreover, the smooth exterior, comparative shortness, and firmness of the charges, rendered the loading of holes easier, and the liability to accident through the jamming of the charge was considerably reduced. With respect to economy of production and consequent power of competing advantageously with gunpowder in point of price, as well as in regard to saving of time and labour, the new system of manufacture has greatly improved the position of gun-cotton, while at the same time it secures greater purity and uniformity. The necessity for employing long-staple cotton is dispensed with, waste clippings being substituted; the purification is far more thoroughly and expeditiously accomplished when the fibre is reduced to a fine state of division, and the products of many small operations are intimately incorporated and made to furnish, upon a large scale, material of very uniform quality. Safety in transport and manipulations with the material is also very greatly promoted by conversion of gun-cotton into the homogeneous compressed form; if accidently ignited, the latter burns rapidly, but does not explode under ordinary conditions, while the gun-cotton rope or other forms of the substance at once burn explosively.

As in the case of gun-cotton in the form of rope or plait, compressed gun-cotton, if inflamed by ordinary methods, also requires strong confinement for the full development of its explosive force; hence, though its efficiency as a mining agent and for torpedoes was undoubted, its employment for many military engineering purposes presented no decisive advantage until within the last three years.

While the manufacture and applications of gun-cotton were being developed in this country, a Swedish engineer, Mr. Alfred Nobel, was devoting himself, and with great ultimate success, to the utilisation of an explosive compound corresponding in its nature to gun-cotton, a liquid substance produced from the sweet principle of oils and fats, known as glycerine, by a method quite similar to that followed in the preparation of gun-cotton. Although this substance, *nitroglycerine*, was discovered within a year of the first production of gun-cotton, no attempt was made to apply it to practical purposes, until sixteen years afterwards Nobel proposed to saturate the grains of gunpowder with this liquid, and thus add greatly to its explosive force. This scheme for utilising nitroglycerine did not lead to important results, but was speedily succeeded by Mr. Nobel's discovery of a satisfactory method of developing the explosive force of the liquid when used either in its pure state or mixed with other substances. Proceeding upon the idea that, in order to accomplish the violent explosion of nitroglycerine and analogous bodies, it was necessary to heat some portion of the mass to the exploding temperature, and thus develop an initiative explosion, Mr. Nobel suggested several methods of accomplishing this; the only really successful one, which depended for its success upon the submission of a small portion of the nitroglycerine to a sudden concussion, or species of blow, consisted in exploding a small confined charge of violently detonating powder in contact with the nitroglycerine. By this device the explosive force of the liquid was instantaneously developed and transmitted throughout the mass; confinement of the material being consequently unnecessary. This method of exploding nitroglycerine was sufficiently certain of action to render the substance susceptible of employment as an efficient blasting agent, and its liquid form, combined with its high specific gravity and insolubility in water, even secured to it some special advantages, as it could be rapidly introduced into blast-holes, and might be exploded in wet holes, or under water without any protection. But, although it was still more powerful than gun-cotton in its explosive action, its employment was soon found to involve so great a risk of accident during transport, storage and use, as to render it an exceedingly dangerous material. Its liability to escape from a blast-hole into fissures in the rock, where it might lead to unavoidable explosions during subsequent operations of driving holes, and its leakage through any minute imperfections in the packages in which it was stored and transported, became fruitful sources of accident, which were but little affected by adopting the precaution of keeping the nitroglycerine diluted with wood-spirit until required for use; for though the solution thus produced was non-explosive, if sufficient spirit were employed, an explosive mixture of nitroglycerine and spirit was liable to separate from it when the latter became reduced in strength by evaporation through any imperfections in the packages. These serious objections to the utilisation of nitroglycerine were overcome by Mr. Nobel in 1867, when he found that it could be exploded by detonation as readily (and even with greater certainty) if mixed with solid substances, which might be perfectly inert in character, as when used in the liquid form. He was thus led to the production of solid but plastic preparations of this substance, to which he gave the name of *dynamite*. The earliest of these supplied to the public, and the one which, in its present improved form, is decidedly superior to any other nitroglycerine-preparation in point of safety in storage, consists of 75 parts of nitroglycerine held absorbed by 25 parts of a porous infusorial siliceous earth, existing abundantly in Germany, and known as "Kieselguhr." The mixture was first supplied in the form of a loose unctuous powder, from which the nitroglycerine appeared to have some tendency to separate; it is now converted by pressure into small cylindrical rolls, or charges, which are wrapped in parchment paper, and from which, as far as the lecturer's limited observation goes, the liquid exhibits no liability to exude, even upon prolonged exposure to elevated temperatures, though immersion in water will cause a separation of nitroglycerine after some time. During the siege of Paris, when dynamite factories were established at the Buttes Chaumont and La Villette, many experiments were made to ascertain what absorbent material could be best substituted for kieselguhr, which was unattainable. Kaolin, precipitated silica or alumina, sugar, and one or two other substances, were found to act very fairly as absorbent media, and eventually the ashes of Bog-head coal were employed as most efficient; but the material selected by Nobel appears undoubtedly to rank highest in its power of absorbing and retaining a very large amount of nitroglycerine. Besides the "kieselguhr" dynamite, Nobel has devised another form of the preparation (called No. 2 dynamite), which contains a much smaller proportion of nitroglycerine, mixed with finely-powdered saltpetre and resin or coal, and is intended for use as a blasting agent intermediate in character between No. 1 dynamite and gunpowder. Several other similar preparations have been devised, in all of which the porous silica has been partly or entirely replaced by solid substances of explosive or semi-explosive character. Among these, the following may be named as having received some amount of practical application; Colonia powder, which consists of a modified gunpowder impregnated with nitroglycerine; Horsley's powder, composed of his chlorate of potash and nut-gall powder impregnated with 20 per cent. of nitroglycerine; Dualine, which may be described as Schultze's sawdust powder impregnated with nitroglycerine; Glyoxiline, which consists of a mixture of gun-cotton pulp and saltpetre, converted into porous pellets, which are saturated with nitroglycerine, and afterwards coated with varnish or other protective materials; and lithofracteur, in which the silicious earth and nitroglycerine of Nobel's dynamite are partly replaced by some explosive material, *i.e.*, by substances which fulfil the part of the gunpowder in colonia powder, or of the charcoal and saltpetre in Nobel's No. 2 dynamite. It need scarcely be said that all these preparations partake of the properties of the original dynamite, though they differ considerably in their nature. The first four consist entirely of explosive material; of these, Horsley's powder and glyoxiline probably approach most nearly to dynamite in their explosive power.

So far as the composition of lithofracteur has been made public, it is known to contain less nitroglycerine than Nobel's ordinary dynamite; the solid materials which it contains include silicious earth and sand, saltpetre, coal, and sulphur. Some good practical experiments have been made with this preparation on two occasions at the Nantmawr and Breidden Quarries, near Shrewsbury, which satisfactorily demonstrated its safety in transport and use, when in its normal condition. In this, as in all other nitroglycerine preparations containing solid materials of inferior absorbent power to Kieselguhr, freedom from liability to a partial separation of the liquid can obviously be only secured at a sacrifice of explosive power, by a reduction of the proportion of the nitroglycerine; and it is difficult to conceive that the consequent loss in power can be compensated for by the employment of solid explosive materials less violent in their action than nitroglycerine as components of the preparation.

Both dynamite and lithofracteur were used by the Prussians during the late war in some hasty demolitions, and for the destruction of guns and other operations for which compressed gun-cotton has been so successfully applied by the Royal Engineers during the last four years, and of which Colonel Fisher gave an interesting account in his lecture at this Institution in 1870.* Dynamite was extensively manufactured by the French in Paris during the latter part of the siege, and a small corps was organised and placed under the command of a "Capitaine de Dynamiteurs," who was very expert in the use of the material. Among the purposes to which it was usefully applied was the breaking of the ice when the Seine was frozen, and the consequent relief of a flotilla of small gunboats, which had become blocked in a position where they were useless. The Communists appear afterwards to have attempted to use dynamite extensively, but with no important success. Occasional serious failures in operations which were attempted both with dynamite and lithofracteur appear to have been mainly ascribable to the charges, or portions of them, having been at the time in a frozen condition.

The tendency of nitroglycerine and its preparations to freeze at a comparatively high temperature, and the necessity for thawing them, by application of heat, before they can be used with certainty of success, constitute a defect which, from a "service" point of view, is serious, as it cannot but interfere importantly with the safe, expeditious, and effective employment of these materials in military operations under many circumstances likely to arise in active service.

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* "Gun-cotton applied to Demolitions," by Colonel Fisher, C.B., R.E. See *Journal*, vol. xiv, page 419 *et seq.*

When first nitroglycerine and dynamite began to receive application, it was believed that the readiness with which they freeze, constituted a special source of danger; this belief was founded upon the well-established fact that the susceptibility to detonation of an explosive substance is in some direct proportion to the rigidity of the mass, and the consequent resistance to mechanical motion which its particles oppose to the force applied, and the opinion appeared to be confirmed by several disastrous accidents which occurred in the manipulation of frozen nitroglycerine. There is now no doubt, however, that those accidents must have arisen from specially incautious handling of the frozen material, and that the substance and its preparations are very much less easily exploded by a blow when frozen, than when in the normal state. This must, doubtless, be at any rate chiefly ascribable to the fact that the transformation into gas of the solid substance, which has been robbed of much latent heat by the freezing, must involve a greater expenditure of heat than that of the liquid in its normal condition, and hence the frozen substance will resist explosion by percussion or friction to a greater degree.

The fact that dynamite, and similar preparations, when once frozen will continue so even long after the atmospheric temperature has reached or somewhat exceeded 50°, and that they are then comparatively passive in their nature, necessitates the provision and careful application of special regulations and arrangements for thawing the material. This thawing operation may be carried out with perfect safety, but accidents have repeatedly happened in connexion with it, being due either to ignorance or want of caution, both of which are exceedingly difficult to guard against effectually in ordinary service. Moreover, the fact that this extra operation would frequently be necessary in military applications of dynamite and similar preparations, would be a source of considerable inconvenience, especially when hasty demolitions and other operations have to be carried out, in which a saving of time is of the first importance.

There is another peculiarity of nitroglycerine-preparations which cannot fail to be occasionally of considerable inconvenience in the application of those materials to service-purposes, namely, the injurious effects which they exert upon the health of persons who have to handle and use them. It is stated that the human system loses in time its susceptibility to the poisonous influence of nitroglycerine by constant contact with the material, and that the people employed in nitroglycerine and dynamite factories suffer no inconvenience after a time; sufficient experience has probably been scarcely acquired as to ultimate effects upon the constitution of those constantly subjected to the influence of nitroglycerine, but there is no question that those who have only occasionally to work with it, or its preparations, as would be the case in their employment on service, must always be sufferers in a greater or less degree from the deleterious effects of the substance.

The perfectly innocuous character of gun-cotton, and the fact that its susceptibility of explosion is not affected by cold, render this material a decidedly safer and more convenient explosive agent for war-purposes than dynamite or other nitroglycerine mixtures. With regard to its explosive power, and its susceptibility of expeditious and effective employment in all classes of military and naval operations in which great violence of action is of special advantage, the circumstance that compressed gun-cotton may be readily exploded by detonation, places it at least on an equality with the best of those materials when used under conditions most favourable to their efficiency. In addition to its special advantages above pointed out, the transport of compressed gun-cotton in the field during active service is attended by decidedly less risk of accident than with nitroglycerine preparations. Numerous experiments have shown that both strong and light boxes containing compressed gun-cotton, as closely packed and securely confined as possible, are not exploded when penetrated by rifle bullets, the contents of such boxes are simply inflamed, but in every instance in which packages (of wood, and even of cardboard) containing dynamite and other nitroglycerine mixtures have been fired into, the result has been a violent detonation.

The great superiority of compressed gun-cotton and of efficient nitroglycerine preparations (such as Nobel's No. 1 dynamite) over gunpowder in all operations where rapid destruction is to be accomplished, has now been most fully established. Not only would a very much larger quantity of powder be required to produce similar results, but, in some instances, it would be impossible to perform the same operations even with exorbitantly large charges of powder. This is especially the case in the breaking up of masses of hard rock and of metal (*e.g.*, large castings and forgings, guns, &c.), by the superposition of the explosive agent, or its simple insertion into cavities or perforations. Again, in tunnelling and blasting in hard rock, gun-cotton and dynamite possess advantages. Important economy is effected by their use, not merely in regard to cost of material to produce a particular result, but also in regard to saving of time, of labour, and of tools. Short charges and long tamping (which need not be hard tamping) insure the breaking up of the hole to the bottom, and generally tend to break up the rock beyond the bottom of the hole. The holes may be of comparatively small diameter, and are more rapidly loaded with the new explosive agents, especially if they are horizontal, or driven at an upward angle. In the hasty demolition of stockades, bridges, and most kinds of military works, the great importance of rapidly placing and firing the charges, renders the violent explosive agents of special value, on account of the very considerable reduction in the weight of charge required, and of the possibility of operating effectively without the aid of lamping.

Full details have been given in Colonel Fisher's interesting lecture regarding several operations of this class which have been carried out by the Royal Engineers with compressed gun-cotton, which material.

for the reasons already given, is unquestionably preferable to nitroglycerine mixtures for service applications of this kind.

As an explosive agent for submarine mines, the special advantages of compressed gun-cotton have been established already by numerous experiments. It is difficult, in the absence of direct experience of the effects produced by this material (or by dynamite) when used against ships of modern structure, to make more than an approximate estimate of the comparative effects of gunpowder and compressed gun-cotton; it would appear, however, from such experimental results as may be considered reliable, that the destructive action of the latter, when used in torpedoes, is more than four times, and more nearly six times that of an equal weight of gunpowder exploded under the most favourable conditions. Satisfactory comparative experiments with respect to the area of destruction of the two agents are still much needed.

In ordinary blasting operations in hard rock, compressed gun-cotton, and Nobel's No. 1 dynamite, appear to be about on an equality as regards power, and to furnish results equal to about six times those obtainable with an equal weight of ordinary blasting powder.

For work of this kind the particular dynamite specified, and similar nitroglycerine compositions, possess the advantage of plasticity, which admits of the more ready and somewhat heavier charging of rugged and uneven holes than with compressed gun-cotton; on the other hand, the latter requires no special treatment before use in cold weather, and is quite innocuous.

The shattering and splitting effects of dynamite and gun-cotton in hard rock are much greater than with powder; but in quarrying, the rock is generally not thrown off by them to the same extent. It is frequently found very advantageous, in rapid working, to drive large and deep holes far back from the face and charge these with the violent explosive, by which the rock is very extensively fissured; large quantities of powder are then poured into the fissures, and by its explosion enormous quantities of rock are removed. In submarine blasting, a similar mode of combining the shattering and displacing effects of the violent and gradual explosive agents has been found very advantageous. In submarine demolitions, as in the destruction of wrecks (on which subject Lieutenant Jekyll, R.E., delivered an interesting lecture at this Institution in 1869),* the violent explosives generally have a very decided advantage; but in some operations upon iron ships it has been found that the lifting effect of very large charges of powder is advantageous in clearing away framework and other parts which have been shattered but not actually removed by the violent explosive agents.

When a very moderate clearing and separating effect is required, accompanied by as little local action as possible, gunpowder cannot at present be advantageously replaced, and in earth-mines, where great displacing action is required, gunpowder has the undoubted advantage. In the submarine blasting of very soft rock, such as soft limestone or chalk rock, the comparatively instantaneous action of the violent explosion operates disadvantageously in regard to their displacing power.

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* See *Journal*, vol. xiii, page 395 *et seq.*

As an illustration of this, some experiments made under Mr. Hawkshaw's direction, in June, 1870, upon the foreshore, near the Shakspeare Tunnel, at Dover, may be referred to. The object was to ascertain whether the detonation of gun-cotton charges, placed upon the surfaces of submerged soft chalk rock, would break up the latter to such an extent as to facilitate the rapid removal of the rock by dredging. The results showed that the rock was completely disintegrated, or pounded into a plastic mass like clay, within a comparatively limited area; but that the shattering or rending of the rock did not extend to any considerable distance, as it would have done in the case of hard rock, of which the portions contiguous to the charge would have presented greater resistance to the blow exerted by the extremely rapid explosion.

The degree of safety with which explosive agents may be produced on a large scale is an important consideration connected with their extensive application. The fact that the manufacture of gun-cotton, as now carried on, involves not the slightest risk of explosion up to the final stage when the material is dried, distinguishes it from most other explosive agents. In gunpowder manufacture, liability to explosion exists throughout all the operations from the point when the ingredients are mixed; and with regard to nitroglycerine, it appears that, up to the present time, occasional severe accidents during manufacture have been inevitable; they probably arise chiefly from occasional neglect of essential precautions during the several manipulations with the explosive liquid. The immunity enjoyed by gun-cotton is due to its being wet, and therefore absolutely uninflammable, throughout all stages, even after it leaves the machine in which it has been compressed into cakes or disks. At this point it contains 15 per cent. of water, the expulsion of which by desiccation is unattended by any liability to explosion, or even to ignition, if very simple precautions are adopted. For purposes of storing large quantities with absolute safety, it is very convenient to preserve the compressed gun-cotton in the moist condition, as it is delivered, in fact, from the presses. It has been stored damp for very long periods, without any detriment, and its non-inflammability in this condition is aptly illustrated by the fact that the perforations required in some of the charges are produced by drilling the damp gun-cotton, in which operation the drill used revolves at the rate of about 600 revolutions per minute. The gun-cotton employed in some extensive experiments recently made at Hastings, had been stored in the damp state for nearly nine months, and was dried partly in the open air, and partly in a hot-air chamber, when required for use. On that occasion 6 cwt. of the damp gun-cotton, packed in 24 strong wooden boxes, were stored in a wooden shed, and surrounded by inflammable material. The building was then fired, and soon burned fiercely; it continued to do so for about half-an-hour, when the fire gradually subsided, and the building and its contents were entirely consumed; the gun-cotton must have burned away gradually, as the surfaces of the masses became sufficiently dry, but at no period of the experiment was there even any burst of flame, due to rapid ignition, perceptible.

One most important consideration connected with the possibility of extensively employing an explosive compound or mixture as a substitute for gunpowder is the question of its stability. Mixtures of saltpetre or potassium chlorate with oxidisable substances of stable character, may be generally relied upon to equal gunpowder in their unalterable nature under all conditions of storage and use in different climates; deterioration in explosive power by the absorption of moisture is the only prejudicial result which generally attends long-continued keeping of such mixtures. There are a few instances, however, in which absorption of moisture may in time establish slight chemical action between the compounds of such mixture, and thus become not only a cause of more serious deterioration, but also a source of danger, as chemical activity, if once started in preparations of this kind may gradually increase, being promoted by the heat developed, until it may attain a violence resulting in the spontaneous ignition or explosion of the mass.

Although the stability of *compounds* which are endowed with explosive properties, may be perfectly reliable when the substance is in a chemically pure condition, it is susceptible of being seriously affected by comparatively minute causes, hence the most scrupulous care in the production and purification of such substances is imperatively necessary, and in this respect they compare disadvantageously with gunpowder, as a want of care in the production of the latter, though it may lead to accident during manufacture or to inferiority of product, will not affect the stability of the material.

Both nitroglycerine and gun-cotton, when prepared in small quantities and carefully purified, have been long known by chemists to be subject to very gradual chemical change when exposed frequently to sunlight, and also to be liable to slow or rapid decomposition if exposed to temperatures considerably higher than occur as extremes under natural conditions in any climate. Both are also well known to have exhibited great stability under normal conditions of preservation, and even when continually exposed to light; but though many specimens exist, which have remained unaltered almost since the first discovery of these bodies a quarter of a century ago, the instances are numerous in which laboratory specimens have undergone spontaneous change with more or less rapidity.

The apparently variable nature of these substances as regards stability, is due to the retention by them, in some instances, of small quantities of comparatively unstable impurities derived from foreign matters contained in the cellulose or glycerine; exposure to heat or sunlight developes changes in these, resulting in the production of acid substances; hence, if they exist in gun-cotton or nitroglycerine, they may constitute the starting point of decomposition when these are exposed to high temperatures or to the influence of sunlight. If they exist in gun-cotton, they will be, to some extent, enclosed in the hollow fibres, and are then only removed effectually by breaking up the latter, and long continued washing. In nitroglycerine they are held obstinately dissolved by the liquid, and their removal can also only be effectually accomplished by a long protracted washing of the very finely-divided substance. Alkaline agents are in both cases useful in accelerating purification.

For many years nitroglycerine was universally regarded as specially liable to spontaneous change; even samples of different quantities of several pounds each, which, within the last four years, were produced at Woolwich in immediately successive operations, all apparently under the same conditions and with the special object in view of obtaining a thoroughly purified material, have exhibited great differences in their keeping qualities. They have all been preserved in the dark, side by side; some are in their originally pure condition; others have become more or less strongly acid, and two or three have undergone complete metamorphosis into oxalic acid and other products. The manufacturing and purifying processes, as perfected by Mr. Nobel, appear to furnish more reliably uniform products than those usually obtained on a small scale, and such specimens of these products as the lecturer has had an opportunity of examining, have exhibited great stability. Yet, if it were possible to trace explosions to their cause more frequently than is the case, an accidental want of stability might perhaps have been found, in some instances at any rate, auxiliary in bringing about the violent nitroglycerine explosions which have occurred. It has, however, been already established by very extensive experience during the last three years, that nitroglycerine is a far more reliable material than was formerly believed, and that if the most scrupulous attention is paid to its purification, and is combined with vigilance during storage and use of its preparations, and the adoption of certain precautions, which have already been proved important safeguards against chemical change in materials of this class, the risk of accident is so greatly reduced as to warrant the extensive manufacture and employment of nitroglycerine preparations under restrictions similar to such as may be deemed sufficient in the case of other explosive agents.

The causes which led to the great uncertainty with regard to stability exhibited by gun-cotton in the earlier days of its history, have been discussed by the lecturer in former discourses. The important improvements, in point of uniformity of composition and stability, effected by the labours of von Lenk, were considerably added to when the system of reducing gun-cotton to pulp was thoroughly developed as a manufacturing process. But the very extensive experiments and observations which were set on foot nine years ago by the Government Committee and have been continued to this day, on the keeping qualities of gun-cotton prepared by the Austrian process, have furnished most satisfactory results; very considerable quantities of gun-cotton in a great variety of forms have been stored at Woolwich for several years, and their periodical examination has failed to afford any reason whatever for doubting the stability of gun-cotton under all conditions of storage which are likely to occur. The experience thus gained applies even more favourably to gun-cotton manufactured according to the system lately in use, whereby the uniform purification of the gun-cotton is more effectually secured. Compressed gun-cotton has not only been stored extensively in different parts of Great Britain, it has also been exported in considerable quantities to Australia, the West

Indies, South America, and other distant countries, and has been used under circumstances specially trying to any material of uncertain stability.

The explosions which occurred at Stowmarket ten months ago, had the natural effect of dispelling from the public mind the great confidence which was becoming very generally entertained in the stability of gun-cotton as now manufactured. Fortunately, the facts which were elicited in the course of the consequent enquiry, constituted so complete a chain of evidence, as to place the first cause of the explosion beyond any reasonable doubt, and to demonstrate that it was quite independent of any want of stability of the properly manufactured material. A supply of gun-cotton delivered from the works at Stowmarket, forming part of a quantity of which there remained a store in the magazines that exploded, was found to contain a proportion of disks in a highly impure condition. The proportion of free (sulphuric) acid existing in some of these was so considerable, that it could not possibly have been left in the gun-cotton after the first rough washing which it receives immediately on removal from the acid, and *before* it is converted into pulp in the rag-engines, where it is beaten up for several hours with a very large volume of water. Supposing, therefore, that the gun-cotton pulp out of which these disks were formed had been submitted to the compressing process without being passed through the intermediate and principal purifying operation, it could not possibly have contained even a small proportion of the sulphuric acid which was discovered in the impure disks, and the same would have been the case even if the *un*pulped gun-cotton, after the preliminary washing and wringing, could have been converted into compressed disks. It was indisputably established therefore that the sulphuric acid discovered in the impure samples, and which could not have been generated by any decomposition of the substance, must have found its way into the finished material in some manner totally unconnected with the process of manufacture, and that no amount of carelessness in manufacture, even to the extent of partial omission of the purifying processes, could have led to the existence of the acid found in the impure gun-cotton. That this impurity was sufficient to establish rapid change, was sufficiently proved by the condition of some of the disks; and, that this chemical change, accelerated as it was by the great heat of the weather at the time, gave rise to a development and accumulation of heat inevitably culminating in the ignition of some portion of the stored gun-cotton, was readily demonstrated by simple experiments with some of the impure disks themselves. But, although the *ignition* of the store of gun-cotton in the slightly-built magazines at Stowmarket was completely accounted for, the very violent character of the explosions, and especially that of the second explosion of a small store which was burning for a considerable time before its contents detonated, were results quite unexpected to those well acquainted with the properties of gun-cotton in the compressed form. Many practical experiments had demonstrated that it might be submitted to extremely rough treatment without any risk of explosion, and single packages of the closely confined material had been repeatedly ignited, from both within and without, no other result than an inflammation and a rapid burning of the gun-cotton having ever occurred. These demonstrations of the apparent immunity from explosive properties of compressed gun-cotton, unless very strongly confined or fired by detonation, appeared to be convincingly confirmed by the results of a somewhat extensive experiment made at Woolwich in March, 1871, with gun-cotton packed in firmly closed very strong wooden boxes of the kind which Government proposed to use for storing the material. Eight such packages, each containing 28 lbs., were enclosed in a pile of similar boxes loaded to the same weight, and the contents of the centre box were ignited; no explosion resulted, and the contents of some of the boxes even escaped ignition. A second experiment, in which the centre box was surrounded by inflammable matter, so that a fierce fire burned in the centre of the heap for many minutes before the contents of that box ignited, was also unattended by any approach to an explosion.

The apparently conclusive nature of these experiments undoubtedly encouraged a false confidence in the non-liability to explosion of stores of gun-cotton in the event of accidental ignition; and the explosions at Stowmarket demonstrated the imperative necessity for a more extensive investigation of the subject. The results of some experiments recently instituted near Hastings by the Government Committee on Gun-cotton, have already served to throw great light upon the manner in which those explosions were brought about. In the first instance, 24 boxes (containing 6 cwt. of gun-cotton) of the kind used in the earlier experiments, were stored upon tables in a small wooden shed of light structure, and a heap of shavings and light wood was kindled immediately beneath the boxes, two of which were left partly open. After the fire had been burning for about seven minutes, the gun-cotton inflamed, and continued to burn with very rapidly increasing violence for nine seconds, when a sharp explosion occurred. A very similar result was furnished by a second experiment, in which an equal number of boxes of gun-cotton was stored in a small magazine of stout brick work. By subsequent comparative experiments it was judged that a considerable proportion of the gun-cotton had been burned in both instances before the explosions occurred, but these were, nevertheless, of such violence as to produce large craters in the shingle on the side of the buildings, and to project the débris with much force to considerable distances. Two repetitions were afterwards made of the first experiment, in wooden sheds of similar structure, and with corresponding quantities of gun-cotton similarly arranged in boxes of the same size, and fastened down just as securely as those used in the former experiments, but the boxes were made of somewhat thinner wood, and were constructed less strongly. In neither of these experiments did an explosion occur. In the one instance the fire was burning in the building for more than half an hour before the gun-cotton became ignited, and three minutes after the first great blaze had subsided, there was a second blaze of gun-cotton; although the latter must have been exposed to intense heat, no explosion was produced. In the second experiment the gun-cotton burned in three successive portions, the last having been exposed for many minutes to a very fierce heat, yet burning non-explosively.

The first two of these experiments demonstrated that if, in a store containing packages of gun-cotton in somewhat considerable number, the material became accidentally inflamed, the intense heat developed by the burning gun-cotton in the first instance might raise some portion, still confined in boxes, to the inflaming point, and that the mass of the confined gun-cotton being in a heated condition, the ignition would then proceed with such rapidity as to develop the pressure essential to explosion while the gun-cotton was yet confined, the explosion being then instantaneously transmitted to other boxes.

When the magazines at Stowmarket exploded, a large volume of flame was observed to precede the explosion by a very distinct interval.

The two other experiments described appeared to demonstrate that *with such quantities* of gun-cotton as were stored in the experimental sheds, the fact of the material being confined in boxes of comparatively light structure constitutes a safe-guard against explosion, the reason being that the weaker packages are opened up by comparatively feeble pressure from within; hence, when the contents of a box become raised to the igniting temperature, or become ignited by the penetration of flame to the interior, the pressure developed by the first ignition is not sustained by the box to a sufficient extent to bring about explosion.

On the occasion of the Stowmarket catastrophe there were two store-sheds containing gun-cotton packed in boxes of light structure, which were ignited by the first explosion, and burned out without exploding, while a third, which contained gun-cotton packed in the strong Government boxes, exploded with great violence after having been in flames for some time.

Simple experiments demonstrate that if any explosive compound or mixture be ignited when in a heated condition, it will burn with a violence proportionate to the temperature to which it has been previously heated; if this be near the exploding point, explosion must ensue, which will be violent in proportion to the strength of confinement of the material. A practical demonstration of this was furnished by an explosion which occurred at Woolwich in 1866. Several very strong packages (metal lined cases) filled with von Lenk's gun-cotton, some of which had been purposely left impure, had been exposed for seven months to artificial heat in a strong brickwork chamber heated by steam. The impure gun-cotton in some of the packages was then known to be in a decomposing state, but the experiment was continued, and eventually spontaneous ignition occurred, and at a time when the boxes were heated to the maximum temperature. The result was a violent explosion of all the packages; the very strong confinement, and the heated condition of the gun-cotton which ignited, added to its being at the time in a state of chemical activity, determined its explosion, and the explosion of the other packages was a necessary consequence of the violent concussion to which they were exposed.

There can be no doubt that the results of the recent experiments, and of those made last year, as also the results of the Stowmarket accident, have to be considered in relation to the *quantities* of gun-cotton operated upon, as well as to its confinement. The confinement of the *eight* strong packages by the layers of boxes which surrounded them on all sides in the Woolwich experiment, was probably quite as great as that afforded by the light and roomy shed in which the *twenty-four* boxes of the same kind were placed in double layers in the South Coast experiments; yet in the latter case an explosion was developed, and not in the former with the smaller quantity. In the South Coast experiments, with 6 cwt. of gun-cotton, the explosions occurred eight seconds and ten seconds after the ignition of the gun-cotton; in the Stowmarket magazine, where several tons of gun-cotton were stored, the explosion appears to have *almost* immediately followed ignition; it must be borne in mind, however, that in this case much of the gun-cotton was very closely confined by the large number of surrounding packages, and that the temperature of the gun-cotton was already raised considerably throughout by long-continued very hot weather. Both of these circumstances must have greatly favoured the very rapid development of explosion, independently of the much more intense heat generated by the rapid spreading of fire through a large portion of the gun-cotton.

The satisfactory results obtained in the South Coast experiments with the lightly constructed boxes, with employment of 6 cwt. of material, appear to have received confirmation from the result of an accident which occurred in 1869 at Penrhyn, when a magazine of brickwork containing 20 cwt. of compressed gun-cotton, packed in boxes of light structure, was burned down without any explosion. But it is nevertheless very possible that a similar result would not be furnished by several tons of gun-cotton similarly packed; the much higher temperature which would be developed in that case by the first spreading of the fire, and the additional confinement, due to the larger number of packages, might combine to develop conditions favourable to the violent explosion of some portion of the mass; though, no doubt, a much larger proportion would burn non-explosively than if strong boxes were used. While, therefore, in storing *dry* gun-cotton the probability of violent explosions resulting from the accidental ignition of a magazine may be considerably diminished, or at any rate the violence of a possible explosion much reduced, by storing the material in packages of which some portions will yield readily to pressure from within, or by adopting any other storage arrangements (such as stacking upon lattice shelves) whereby the rapid penetration of flame or heat between the compressed masses is promoted, it must be considered as conclusively established by the last twelve months' experience, that such regulations as experience and prudence have rendered essential in connection with the storage of gunpowder and other explosive agents, must also apply to the storage of compressed gun-cotton when in the dry state.

Some results, which promise to have an important bearing upon the economical and efficient application of gun-cotton to naval and military purposes, have recently been obtained by the lecturer. It is well known that gun-cotton does not in itself contain sufficient oxygen to oxidise thoroughly the whole of the carbon in the substance, hence the full explosive force attainable through the agency of that carbon is not developed; moreover, the products of explosion of gun-cotton contain a proportion of the inflammable gas carbonic oxide, the production of which may occasionally, in underground working, be attended by considerable inconvenience. The idea of furnishing the carbon with some additional oxygen, by *impregnating* the gun-cotton with saltpetre, or chlorate of potash, was entertained and worked out to some extent soon after the discovery of the substance, but the quantity of those oxidising agents which could thus be incorporated with the material was too small to produce any important practical results. The reduction of gun-cotton to a fine state of division by the pulping process, furnishes this substance in a condition in which it can readily be incorporated with any desired proportion of saltpetre, or of a chloraly, and the mixtures thus produced can readily be granulated, or converted into compact masses by compression.

Successful experiments with granulated gun-cotton thus produced were made several years ago in Mr. W. B. Beaumont's mines and quarries at Allenheads, and the granulated mixture was also used by Mr. Abel in 1868 as a vehicle for the employment of nitroglycerine, under the name of "glyoxiline."

"Nitrated" and "chlorated" gun-cotton in compressed masses, similar in form to ordinary compressed gun-cotton, have recently been made the subject of experiment at Woolwich, with satisfactory results. These compressed mixtures may be so manufactured as to produce equal, and in some instances superior, results to ordinary compressed gun-cotton at less cost; they are readily susceptible of detonation, and the fact that the gun-cotton particles are separated from each other by the interposition of salts which resist great heat without change, has been proved of decided importance in enabling them to withstand long-continued exposure to high temperatures. These compressed gun-cotton preparations are at present the subject of experiment by Government.

Gunpowder itself has not remained stationary during the development which has of late taken place in the application of violent explosive agents to naval and military purposes. In pursuing the investigation of the nature and causes of the phenomena exhibited by nitroglycerine and gun-cotton when submitted to the action of a detonation, Mr. Abel found that not only all explosive compounds, but also explosive mixtures, including gunpowder, are susceptible of violent explosion, even when quite unconfined, through the agency of a detonation, though the nature and violence of this detonation varies with different explosive substances. A sufficiently powerful detonating fuze will develop the violent explosion of gunpowder, when not closely confined, and this fact has already received useful application; thus, in submarine operations, it has been decisively established that the employment of detonating fuzes dispenses with the necessity for confining a gunpowder charge in a very strong receptacle. Other interesting results have recently been obtained with gunpowder, which have, however, a more exclusive bearing upon its industrial applications.

Evening Meeting.

Monday, June 17th, 1872.

Lieutenant-General the Right Hon. LORD SANDHURST, G.C.B., G.C.S.I., in the Chair.

NAMES of MEMBERS who joined the Institution between the 28th May and the 17th June, 1872.

LIFE.

Lowndes, James, Major Renfrew Militia.
Fairfax, Henry, Captain R.N.
Geddes, A. D., Captain 27th Regiment.
Martineau, Geo., Lieut. 6th Surrey Rifle Volunteers.
Rigby, Walter A., Major 1st Lancashire Engineer Volunteers.
Wilson, W. T., Lieut. Royal Engineers.
Darwin, Leonard, Lieutenant Royal Engineers.

ANNUAL.

Bax, W. J., Capt. 11th Bengal Cavalry.
Mawson, W. Wilmott, Lt.-Colonel 33rd Lanc. Rifle Volunteers.
Franklyn, E. J., M.D., F.R.C.S., Surg.-Major R.H.A.
Tandy, Dashwood G., Commander R.N.
Borthwick, Alexander, Capt. Rifl. Brig.
Dickins, A. D., Lt.-Col. Beng. Staff Corps.
Gisford, Horace C., Lt. Gren. Guards.
Irvine, M. B., C.M.G., Asst. Controller.
Tytler, J. M. B. Fraser, C.B., Maj.-Gen.
Jary, Robt. H., Mj. late 12th Roy. Lancers.
Lloyd, T. H., Lt. Royal Horse Artillery.
Ballantine, R. F., Lt. 1st W. India Reg.
Goldsworthy, J. W., Lieut. 86th Regt.
Smith, Edwd. Leadbitter, Capt. North Durham Militia.
Pringle, Charles, Captain R.N.
Browne, C. Orde, Captain late R.A.
Clarke, W. A., Capt. North Durham Mil.
Hillyard, G. A., Lieut. Rifle Brigade.
Austin, G. L., Capt. Rifle Brigade.

MILITARY TRANSPORT AND SUPPLY IN INDIA.

By Lieutenant E. H. H. Collen, R.A., Staff College, Sandhurst.

When I accepted the honour of an invitation from the Council of this Institution to read a paper on Military Transport and Supply in India, I did so with considerable reluctance. Beyond the fact that I shoud be addressing Officers whose experience has been so much greater than mine, I felt that the subject was almost too large and intricate to be dealt with by me. Further than this, the time left at my own disposal was extremely limited, and I felt that it would be no light task to compress the vast array of facts and principles into one paper.

At the outset we must start with the recollection that the military machine in India has to be worked for an Army of 180,000 British and native soldiers, scattered among more than 180 military stations and posts, guarding an area of nearly 1,000,000 square miles and peopled by more than 150,000,000 of human beings. This statement is in a certain degree a measure of the difficulties of military administration in India; and, bearing this in mind, I shall ask you to glance rapidly at the main features of that administration, in order that we may clearly understand the points of analogy or difference between the Indian and English systems of supply and transport.

I need hardly remind you that the great empire of British India is divided into several local administrations, at the head of which are

Governors, Lieutenant-Governors, or Chief Commissioners. The chief of these administrations are Bengal, Madras, Bombay, the North-West Provinces, and the Punjab; presided over by Governors or Lieutenant-Governors: and descending in the scale of importance, Burmah, the Central Provinces, Oudh, and Sindh; these latter provinces being administered by Chief Commissioners. For military purposes, however, India may be considered to be divided into three great sections, viz., Bengal, Madras, and Bombay; but under the term Bengal we must place the vast area comprised by Bengal, the North-West Provinces, the Central Provinces, Oudh, and the Punjab; under Madras, Burmah; and under Bombay, the province or district of Sindh.

The Governor-General in Council is the head of all civil and military power. His government is supreme over all the administrations I have just enumerated. The Commander-in-Chief in India is the executive military authority and military adviser of the Government of India, while he also fulfils the duties of local Commander-in-Chief in Bengal. But while stating this, we must remember that the Presidencies of Madras and Bombay, although under the Supreme Government, maintain an independent position in that they are in direct communication with the Secretary of State for India, and that each of these administrations has a local Commander-in-Chief and a Council. In the same manner, therefore, we find in Madras and Bombay distinct Armies and Army Departments, whose administration is to a great extent independent of the Governor-General and the Commander-in-Chief in India.

Returning to the Supreme Government of India, in its military aspect, the Military Member of the Council of the Governor-General is the War Minister of India. Under his especial charge is the Military Secretariat of the Government of India; and, putting aside the fact that the Secretaries are military men, we may look upon this Secretariat as the War Office. This Secretariat comprises an account branch, under the Controller-General of Military Expenditure, who may be compared to the Accountant-General in England. It is the duty of the Controller-General to review all military estimates before final submission to the Financial Department, *i.e.*, the Treasury, and to give the benefit of his advice upon the financial bearing of military questions.

The Military Department of the Government of India, as it is termed in India, which would be known in England under the title of War Department, consists therefore of the Governor-General, his Council (which includes the Commander-in-Chief), and the Military Secretariat, the latter being the agents by which the orders of the Governor-General or that of his delegate, the Military Member of Council, are carried out to the Executive Military power, or to the so-called Civil Departments of the Army. Under this head we have 1st, the Military Account Department; 2nd, the Commissariat; 3rd, the Ordnance, or, as it is officially termed, the Ordnance Commissariat Department; besides the Barrack Department, which is now a branch of the Public Works Department, and the departments known as Stud, Clothing, Medical, Education, &c. I may recall to your minds the fact, which I have before stated, that these Army Departments in Madras and Bombay, are only in a general way under the Government of India, while they are specially under the separate Military Department of their own Government.

In considering the analogy between the Officers of the Control Department in England, and of the Pay and Supply Departments in India, it appears to me that the Officers of the Pay Sub-department of the Control are represented in India by the subordinate Officers of the Pay and Military Account Departments, whose chief in each Presidency is termed the *Controller of Military Accounts*, and this latter functionary would seem to bear also the financial responsibility, which is exercised by the Controllers in the Home Service. The Commissaries of the Supply Transport Branches of the Control Department would be represented in India by the Officers of the Commissariat Department, and by the Commissaries of Ordnance of the Ordnance Department, while the Officers of the Indian Departments also exercise, each in his own sphere, the higher functions of the Controllers in England.

I purpose this evening to try and present to you the salient features of this great subject: first, considering the Departments of Supply, and then describing the system of Transport.

Speaking generally, and without considering the distinctions of Presidencies, there exist two great Supply Departments: the one, the Commissariat, charged with the supply of provisions, forage (in certain cases), fuel, light, bedding, hospital clothing and requisites. The other, the Ordnance Department, charged with the custody and supply of all warlike and military stores necessary for an Army, and all raw materials used in making or repairing these. In addition, we have the Clothing Establishment and Medical Store Depôts in each Presidency. But upon these I shall not touch, because the former is not a separate department, but only a manufactory, while the latter is under the Medical Department.

I shall treat of the Commissariat under three heads:—

Commissariat {
a. Personnel and Administration.
b. Execution.
c. Account.

a. Personnel and Administration.

At the head of the Commissariat Department of each Presidency there is a Commissary-General responsible to Government for the administration of his department, and subordinate to him, Deputy, Assistant, Deputy-Assistant, and Sub-Assistant Commissary-Generals.

In addition to these Commissioned ranks, there are Warrant Officers, Deputy, Assistant, and Deputy-Assistant Commissaries, Conductors, and Sub-conductors, with a further class of Non-commissioned Officers or Sergeants.

The whole of these Officers are drawn from the British or Indian Army, and the total number for all India is 101 Commissioned, and 103 Warrant Officers. All Officers of the British Army are required to enter the Indian Staff Corps, and, with the exception of the Commissary-General, who may be selected from the Army at large, every

Officer must enter at the bottom of the junior grade, while, however, his military promotion goes on in the Staff Corps.

It is a necessary condition of appointment, that an Officer shall have passed the "Higher Standard" examination in the native languages, or corresponding examination, and a preliminary examination. The Officer is then sent for six months to one of the chief commissariat charges to learn the executive duties of the department; after this he joins the office of the Examiner of Commissariat Accounts for three months, and he is then sent to the Head Commissariat Office of the Presidency, where he works under the supervision of the superior Officers of the Commissariat Department.

At the expiration of this year of probation he has to undergo a final examination. This examination embraces many subjects, and I shall venture to allude to them in detail, because it indicates the nature of Commissariat duties in India.

The examination-subjects may be classed under the following heads: —The care and custody of cattle and commissariat stores; the system of procuring supplies by departmental agency or by contract; the mode of rationing British and native troops; departmental rules and returns; the drawing up of estimates and average statements of the cost of victualling troops and feeding cattle; the equipments of cattle, and commissariat stores required for cavalry, artillery, and infantry on the march; cattle for food or transport, breeding, weight, &c.; reading he accounts of native subordinates, in writing orders and letters in the vernacular, and in knowledge of Commissariat Accounts.

The Warrant Officers are appointed from the non-commissioned grade, and these last from the Army. The subordinate establishment consists of native clerks, agents of different grades, workmen, and labourers, fulfilling the multifarious executive duties required of the Indian Commissariat in peace or in war.

The Bengal Presidency is divided into three circles of commissariat superintendence, each presided over by a Deputy Commissary-General, but this division is not carried out in Madras and Bombay.

At each military station in India where British troops are to be found there is a Commissariat Officer, whose rank is dependent upon the extent of what is called the Executive Commissariat Charge. The duties of an Indian Commissariat Officer are various and responsible, for these duties of supply extend over large areas of country; he has to search out the resources of the land; to ascertain what amount of cattle he may demand from the country for provisions or for transport: to enlist the natives in his work; to supervise the reception and care of the materials for provisioning the Army, and their distribution. On the one hand he must maintain intimate and cordial relations with the commanding Officer of the station, and of the larger units of command; on the other he is responsible to the chief of his department, and hence to the Government of India, for the proper carrying out of the principles and rules laid down for his guidance. On the one hand he is enjoined to act in conformity with the wishes of commanding Officers; on the other, should orders be received which are contradictory to the directions of the Commissary-General, the Commissariat Officer must, if personal explanation fail, obey the order, and report the matter to his chief; so that while he is not absolutely a military staff Officer, he subordinates himself, even if senior in military rank himself, to the commanding Officer of the station, acting in accordance with his wishes, while he has also to preserve his departmental relation to the head of his own department.

We now come to the second section, under the heading Commissariat,

b. Execution.

There are two methods of supply in India, apart from the stores furnished from England, viz., 1st direct agency, 2nd contract. Direct agency is now wholly employed in the Bengal Presidency for meat and bread, the latter being made by the Commissariat bakeries. When the contract system is employed, contracts are for one year, and for stations only.

The soldier's ration is, as you know, given free in India, but time does not permit me to do more than mention that the whole subject of the rationing of British troops is so fenced round by regulations and the power of the regimental authorities, that it is very difficult for bad rations or liquor to be issued, and impossible for them to be consumed; while the Commissariat authorities are careful to affirm that the absence of complaints or rejections on the part of the troops will be regarded as tacit proof of good executive management.

The means by which native troops are supplied forms a peculiar feature of the Indian system. As a rule, the Commissariat does not supply rations to native troops, except in localities where food is impossible to obtain by other means; but Government provides for the varying dearness of provisions in different parts of India, by granting compensation whenever the price exceeds that which is laid down for a certain scale of rations. With native troops the bazaar is the supplying agent; this bazaar is a kind of permanent market of native sellers, who make it their business to supply troops with provisions and other requisites. The bazaar is under the control of the military authorities, being under the especial charge of the quartermaster of the regiment. Strict rules are laid down with regard both to the quality of the provisions sold to the troops, and the sanitary and police arrangements of the bazaar.

This method of supply is convenient for the natives, and adapted to the country. It encourages self-dependence; directly enlists the love of gain of the inhabitants of India, and gives them a permanent interest in the supply of the troops for all operations within the confines of our territory; while the superintendence of regimental and medical Officers ensures the just treatment of the supplying agents, and provides for the good quality of the food.

But this system has its disadvantages. It is, as a rule, inoperative in war carried on beyond our frontier; and while the native soldier is ready enough to take his pay, and the allowance granted to him in compensation for the dearness of provisions, he is not always ready to purchase food sufficient for health.

The supply of provisions to hospitals is made by the Commissariat

Department through a hospital purveyor who, although a native subordinate, entertained and paid by the Commissariat, acts under the orders of the medical officer.

Forage in India is supplied by the Commissariat in respect to grain, while the grass is ordinarily procured by grass-cutters belonging to the regimental establishment of mounted corps. In the native cavalry, however, the troopers supply their own forage, receiving extra pay for this service.

Fuel and light are supplied by the Commissariat.

The next division of our subject under the section *b*, *Execution*, may be placed under the heading *Stores*.

Previous to 1861 the Commissariat acted as the purchasing agent for all departments. The evils of this system consisted in the fact that the Commissariat Department had no power to control or reduce expenditure, while a further difficulty was prominent in the labour thrown on the Commissariat. Nor was there any great advantage to compensate for its defects, while it pointed to the principle that a purchasing department ignorant of the exact and ultimate use to which the stores would be put, must necessarily be inferior to the agency of the department actually requiring and using them. Accordingly, Government determined that each department was to be responsible for its own expenditure, and that this expenditure was to be separately exhibited in accounts.

The Commissariat Department supplies all *bedding* and *hospital clothing*.

To give any idea of the number of items which come under the head of Miscellaneous Commissariat stores, would be quite impossible, but we may recollect how various are the requirements of the soldier in India, and that in excess of his wants in England, we must add those necessitated by the climate and peculiar nature of the service. We may, then, before quitting this section of the subject, say, that the Commissariat Department supplies all stores, excepting those which are strictly ordnance, medical, clothing stores, or barrack furniture.

The third section under the heading Commissariat, is that of—

c. Account.

The Commissariat Department in India is not an account department in the strict sense of the word. Every executive Commissariat Officer keeps an "account current," examines the accounts of native agents, forwarding these with the necessary bills and vouchers to the Examiner of Commissariat accounts. This functionary, although he may have been a Commissariat Officer, is not an official of the Commissariat Department, but is under the Controller of military accounts, the chief of the Pay and Military Account Department.

Estimates are prepared by executive officers, collected in the Commissary General's office, and forwarded to Government through the Controller of Military Accounts.

Commissariat charges are divided under two heads:—

I. Commissariat expenditure proper.

II. Expenditure on behalf of other departments.

This second class the Commissariat Examiner audits as well as the first, but debits to the department concerned.

The Commissariat, however, pays one class of charges, viz., all those connected with transport, whatever department those charges may belong to, the amount being ultimately debited to that department. Speaking broadly, the Examiner's functions are to see that moneys and stores are appropriated by executive officers according to orders, and he in fact is the first auditing authority, without the Commissariat Department.

A broad distinction is drawn between financial and Administrative control, and while the Examiner is permitted to make all enquiries necessary for his purposes, he is required to abstain from interference in the administration of the Commissariat Department.

I shall now pass on to describe the constitution and functions of the Ordnance Department, treating this portion of the subject under three sections, viz.:

$$\text{Ordnance}\begin{cases}a.\ \text{Personnel and Administration.}\\ b.\ \text{Execution.}\\ c.\ \text{Account.}\end{cases}$$

a. Personnel and Administration.

Setting aside Presidential distinctions, we may say that the Ordnance Department has charge of all warlike and military stores. Besides all purely artillery stores, and those for the park and siege trains, it takes charge of all small arms and materials for their repair, tools, engineer stores, harness, saddlery, accoutrements, camp equipage, and in fact all the equipments and military stores required for an army. In addition, it has charge of all kinds of raw material required for military purposes.

In each Presidency of India there is a distinct Ordnance Department, with an Inspector-General of Ordnance at the head of each. He is the administering chief and the adviser of Government, and the Commander-in-Chief on all questions of war *matériel.* This functionary has a similar position to that of the Commissary-General, and unless on inspection duties, resides at the seat of Government and Army headquarters. Subordinate to him, are the Deputy Inspector-General and the Commissaries of Ordnance, the latter of whom are graded in three classes, being 26 in number for all India. Again, subordinate to these are warrant officers, styled deputy, assistant, and deputy-assistant commissaries, conductors and sub-conductors, to the number of 198 for the whole of India. Further, there is the Non-Commissioned class or Sergeants. The remaining portion of the Ordnance Department personnel, consists of clerks, artificers, and labourers.

The Commissioned Officers or Commissaries of Ordnance are drawn exclusively from the Artillery. They must have had five years' service, and have passed the examination in the native languages. They are usually selected to fill vacancies caused by Officers proceeding on furlough, and on joining the Department remain "officiating" or "acting" for some time, and they have then to pass an examination in technical knowledge and the conduct of the business of an arsenal. The permanent appointments are now held for five years, during which time the Officer is "seconded" in the regiment.

The Warrant Officers are promoted from the non-commissioned rank, this last class being recruited from all branches of the service, the Inspector-General, through his subordinate Officers, deciding on the merits of the candidates by examination. Those selected are attached to an arsenal, instructed in their work, and if found qualified are permanently appointed. The Deputy Inspector-General of Ordnance is at the head of the Ordnance Office of each Presidency. He administrates the interior economy of the Department, and generally supervises the check and passing of all requisitions for stores, a Commissioned Officer being appointed as his assistant in these duties.

Although perhaps belonging to the next section, viz., *b*, *Execution*, it may be as well to consider in this place the meaning of the terms Arsenal, Magazine, and Depôt, as applied to India. In India an arsenal is an establishment for store and construction; a magazine is a similar establishment of a less important character, especially as regards workshops; while a depôt is merely a place for the store of those articles which are most required by the troops.

The duties of Commissaries of Ordnance in charge of an arsenal are very heavy and responsible. In time of peace all requisitions or "indents" not of an emergent nature are sent by corps or departments through the Ordnance Office of each Presidency. These "indents" are checked by the Deputy Inspector-General, and supply ordered upon the proper arsenal or magazine. It then becomes the duty of the Commissary of Ordnance to carry out this order as expeditiously as possible, either from his stock or by manufacture. He has perpetually to supervise the receipt and issue of stores, to watch and inspect manufacture, to conduct experiments and proofs, to visit in their turn the various establishments under his orders, to conduct the large correspondence of his office, and to overlook and guide the administration of the arsenal. In addition to this, the armaments of forts are in many cases in his charge, although, I am happy to say, these are being gradually placed in the hands of their natural guardians, the Royal Artillery. The Commissary of Ordnance is not a Staff Officer of the General, nor are the stores in arsenals or magazines directly under the military authorities. On the other hand, the Commander-in-Chief, the Generals of Division, Officers commanding stations, as well as the Officers commanding Royal Artillery districts or divisions, have power and are required to inspect the ordnance establishments in their command, and to bring to notice any defects which they may observe.

The next section of my subject under the heading *Ordnance* is—

b. Execution.

In each Presidency of India there are ordnance factories which, although not absolutely belonging to the Ordnance Department, are directly under the Inspector-General of Ordnance, and are in charge of Artillery Officers. Besides these powder factories, the one gun factory, and carriage factories, there are small arms' factories, in charge of selected Commissaries of Ordnance; and in Bengal a harness and accoutrement factory, also in charge of an Ordnance Officer.

Within the last few years, the Government of India determined to carry out the principle that it is advantageous both in a military and financial point of view to maintain good and sufficient arsenals at strategic points than to multiply these bases of supply, thus multiplying danger points necessary to be defended. Accordingly this has been carried out in the Bengal Presidency, in which there are now 3 arsenals, 2 magazines, and 5 depôts, while in Madras there are 2 arsenals, 3 magazines, and 6 or 7 depôts, and in Bombay 2 arsenals, 5 magazines, and 1 depôt, making a total for India of 7 arsenals, 10 magazines, and 12 or 13 depôts.

I shall not try your attention by doing more than mention that an Indian arsenal is divided into stores, or "godowns," and departments of work. Then we have the Issue and Receipt Departments, pattern or "muster" rooms, armouries and armoury workshops, harness and saddlery stores, accoutrement stores, foundry, tool, tent, raw material, and unserviceable stores, the Park, containing the siege trains and artillery heavy materiel, laboratory, and magazines, and workshops. As a rule each of these departments is in charge of a Warrant Officer, in the case of the stores as Storeholder, assisted by a non-commissioned Officer, if necessary, and a native accountant. These Warrant Officers are placed in charge of the various departments by the Commissary of Ordnance according to the branch of the service from which they came and their peculiar fitness for the post.

Stores are obtained from England through the India Office and the India Store Department. They are also manufactured in the Ordnance factories and the workshops, obtained by local purchase, contract, or occasionally from other Departments. As I have stated before, "in-" dents" or "requisitions" for stores ordinarily pass through the hands of the Deputy Inspector-General. If, however, an "emergent" indent is countersigned by Officers commanding divisions, brigades, sections, or detachments, the Commissary of Ordnance is bound to comply with the order, although in the case of the supply being unauthorised, he is equally bound to point out the regulations on that head.

We now come to the third section, viz., *c. Account.*

An arsenal or ordnance establishment is not, strictly speaking, an Account Department. The Office Establishment keeps the store ledgers, collects the returns, accounts, and vouchers. The returns of receipts and issues, with vouchers, accounts of sales of unserviceable stores, contingent bills for extra expenditure, returns of expenditure of labour and materials, are merely compiled and forwarded to the Examiner of Ordnance Accounts, who is an Officer of the Pay and Account Department, under the Controller of Military Accounts, although he may have been an Ordnance Officer, and by this official, the first financial audit is made.

We must now proceed to consider generally the system of transport employed in India. I have divided this under two heads, viz.,

A. *The existing train*, or that which is permanently kept up;
B. *The auxiliary train*, or that which consists entirely of hired animals and vehicles.

A. *Existing Train.*

The general system is under the Commissariat Department, the agent for procuring all transport.

In the first place we must start with the knowledge that no organisation exists in India corresponding to the transport branch of the Army Service Corps.

The first great feature of the Indian system is that at certain important stations transport for "moveable columns" is kept up, so that these columns, which are under the Commanding Officer at the stations, may be ready to move at short notice to repress any disturbance, and to take command of the country. And here I may remark that the existing train is composed of carts drawn by bullocks, pack bullocks, elephants, camels, and mules. The drivers and attendants of this train are Commissariat followers, subject to the native articles of war, although not enlisted soldiers, while the controlling authority consists of European and native Commissariat subordinates, supervised by the Officers of the Commissariat Department.

The present scale of "moveable columns" was fixed in 1861, and for Bengal may be taken, as constituting a force of—

9 batteries, or 54 guns, with the first line of waggons only.
6 squadrons British cavalry.
9 ,, Native ,,
9 battalions British infantry.
12 ,, Native ,,

The Madras and Bombay transport is, I believe, kept up for about one-third of the amount required for the Bengal Presidency, but I have been unable to obtain any details regarding these Presidencies.

Generally speaking, the column may be called a small brigade of all arms, although at places where native troops alone are stationed it may consist only of native cavalry or infantry.

The largest column in Bengal consists of—

1 battery of artillery.
1 regiment of British infantry.
1½ ,, Native ,,
1 ,, ,, cavalry.

And the smallest of all arms of—

½ battery of artillery.
wing of a British infantry regiment.
,, Native ,,
1 squadron of Native cavalry.

In Bengal there are 23 "moveable columns," and if we estimate those in Madras and Bombay together at one-third of the Bengal strength, we should have approximately a force of—

12 batteries.
8 squadrons British cavalry.
12 ,, Native ,,
12 battalions British infantry.
16 ,, Native ,,

Or, in other words, transport provided for a force equal to an army corps of 72 guns, 28 battalions of infantry, and 20 squadrons of cavalry.

The carriage for these moveable columns is maintained at a scale which would enable the column to move out, carrying for the British portion of the force all the numerous requisites of camp life on field service in India.

1. Camp equipage, using the large marquees for soldiers in India.
2. Baggage, at 720 lbs. per Officer, including mess, and men at 50 lbs.
3. Cooking utensils, at 50 lbs. per troop or company.
4. Ammunition, at 120 rounds per British infantry soldier.
5. Rations for seven days.
6. Rum for seven days.
7. Commissariat stores.
8. Rations for natives for two days.
9. Quartermaster's native establishment.
10. Medical and hospital stores.

Besides the conveyance of sick, which I shall speak of under the head of medical transport. It will thus be seen how liberal is the scale allowed, and if we consider that operations might have to be undertaken in the hot weather, perhaps not unnecessarily so, but this is a point to which I shall presently draw your attention.

It would be impossible for me in this short paper, and wearisome to you, to go through the different scales of carriage for the British and Native corps of these moveable columns, and it will be sufficient for me to mention that for mounted corps, while subtracting some of the items I have mentioned above, we must add others, as veterinary stores, scales and weights, bullock gear, and grain, or grain for horses for two days.

For native cavalry and infantry the scale of transport is much less than for British soldiers, as the tents used by natives are much smaller, and the baggage is altogether on a reduced scale.

It will, however, give some idea of the extent of transport necessary in India if I state that a regiment of British infantry equipped on this "moveable column" scale requires about—

41 elephants and 280 camels.

A battery of artillery—

10 elephants and 74 camels.

A squadron of British cavalry—

7 or 8 elephants and 66 camels.

A regiment of Native infantry—
112 camels.

And a squadron of Native cavalry—
9 camels.

This amount I may state includes medical stores, although not medical transport for the sick.

In the Bengal Presidency the authorised transport establishment is, speaking approximately—

1,000 elephants.
6,600 camels.
350 pack bullocks.
530 draught bullocks.
1,500 mules.

Medical Transport may be divided into—

1. Ambulances.
2. Doolies or litters.

With regard to the first, two per regiment is the establishment, but these vehicles are much rougher in construction than those used at home.

The second kind of transport, doolies or litters, is well known, and needs no description from me. In cantonments two doolies are allowed to each regiment of cavalry and infantry, and one to each battery of artillery. It is laid down that half the sick carriage for British troops is to consist of ambulances, and half of doolies. For British troops the scale is for 5 per cent. of sick on ordinary, and 10 per cent. on active service, and for native troops 2 per regiment of cavalry or infantry on ordinary service, and 6 or 8 on active service.

Medical transport is kept up allowing 5 per cent of the strength of moveable columns. The bearers of the doolies for these moveable columns—and we may remember that about 245 are required per British regiment—are employed during the hot weather in pulling punkahs, and other duties connected with barracks. In the cold weather these men, and in fact all the carriage of the moveable columns, are made available, if required, for carrying out the relief of the troops, while generally the commissariat carts and cattle, kept up as permanent transport, are used in the garrison duties of cantonments.

Reserves of bullocks and mules are kept up at various stations.

The next section under the heading A, existing train, is that of *Siege Train or Ordnance Transport.*

At certain strategic points in India siege trains are maintained, and for these large sized bullocks are required and kept up. The equipment is in charge of the Ordnance Department, but the bullocks themselves are under the care of the Commissariat, and, except a few employed on ordnance duties, are used by the Commissariat Department.

For the siege trains in Bengal about 5,000 or 6,000 bullocks would be required, and I think about one-third of that number are maintained as a nucleus of transport.

The *Special Transport* maintained in India is that belonging to the Punjab Frontier Force. This force, consisting of 6 batteries, 5 regiments of cavalry, and 11 regiments of infantry, all native troops, has attached to each corps a certain number of camels and mules, from 30 to 40 of each class, so that it may be enabled to take the field lightly equipped at an hour's notice.

B. *Auxiliary Train.*

The *Auxiliary Train*, which is the second general heading under the subject *Transport*, may consist of hired animals, vehicles, and drivers. These are obtained by the Commissariat through the agency of the civil authorities; and the rules for the payment, care, and treatment of this carriage, which is in a certain way "requisitioned" by the civil power, are very various and strict, differing moreover in different provinces. Before leaving this section of the subject, I may mention that in Bengal the camels even of the existing or permanent train, are hired under what is termed the "Chowdry" system; these "chowdries" being commissariat servants or agents bound to supply the necessary number of camels and camel-drivers. The camels and drivers, although hired, are practically in permanent employ, as they may be collected for inspection at uncertain times, or for employment. There are also hired for the permanent use of the Commissariat Department in Bengal, about 2,000 pack and draught bullocks, and 400 mules.

Railway Transport is provided on the authority of the Officers of the Quartermaster-General's Department; and upon this head I need only remark that the number of carriages required in India for the various arms is greatly in excess of the number necessary in Europe.

Sea Transport is taken up by a board of Staff and Medical Marine Department Officers, the vessels being provisioned by the Commissariat.

Inland Water Transport.—Steamers and flats are usually provided by the authorities of the Marine Department existing at the ports, while boats are procured by the Commissariat Department.

The limit of this paper does not permit me to do more than briefly allude to the action of the Indian Departments of Supply and of Transport in warlike operations.

In time of war, Commissariat and Ordnance Officers become practically the Staff Officers of the General in command, and take their orders from his Staff.

In expeditions beyond our frontier there is practically only one system of supply, that of magazines (using the term in its English signification), unless it be in expeditions of such short duration that the provisions are carried with the troops.

In the Huzara Expedition in 1868, the troops, consisting of two brigades, carried in their haversacks one day's rations, while the Commissariat supplied British troops with biscuits or flour, tea, and vegetables for seven days; the native troops and followers being provisioned on a similar scale. The Force was absent 17 days instead of 7, but the Establishment of Supply-Depôts and the exertions of the Commissariat prevented any scarcity of food being felt.

I shall not enter into the operations of these Departments in the Abyssinian Campaign, as the exhaustive official record of that Expedition gives every particular regarding the supply and transport over a line of communication nearly 400 miles from the base of operations.

In the Lushai Expedition, which has only lately terminated, the two columns advanced through dense jungles, over ranges of mountains from five to six thousand feet in height, and their lines of communication were maintained for four months over a distance of about 200 miles from the primary base of operations; secondary bases and intermediate magazines being established on this long line.

I believe it was intended that the troops should carry two days' food in haversacks, eight days' food on transport animals, and that there should be 14 or 15 days' supply at the nearest advance depôt or magazine, and a supply for four or five months at the base of operations. This, I presume, would very nearly be what was actually done, although I have been unable to obtain any precise information.

In the Camp of Exercise at Delhi, the troops manœuvring consisted of three Divisions, each Division being composed of a cavalry brigade and two brigades of infantry, each brigade including a battery of horse or field artillery; and for this Force 120 elephants, 1,800 moveable column camels, 600 hired camels, 400 bullocks were used in transport operations. Depôts or magazines had to be formed at convenient points, and I believe the Commander-in-Chief declared that the Commissariat Department proved itself equal to every occasion, both as regards supply and transport.

The transport in India during war, or expeditions beyond our frontier, is told off to corps and batteries for regimental requirements; special transport by coolies being sometimes organised. The Medical authorities are in charge of the transport for the sick; the Ordnance officers in charge of that required by the field arsenals and siege trains; while the Commissariat exercises general supervision over its cattle and subordinates attached to corps and departments, as well as over that especially working for the Commissariat service. This is not, therefore, a complete fulfilment of the regimental system, although approximating to it. The only real system is to give each corps its own transport, limited to a minimum; and to make that corps responsible for its efficiency. The objection urged against this is, that when the force is halted, a large amount of transport is locked up; but I would meet this by saying, that it must always be perfectly in the power of the General and his Staff to use regimental transport in any manner he may desire.

In Abyssinia the artillery of the Bengal brigade had its own transport. The consequence was, that it proved eminently useful for general as well as special duties, and the baggage mules were equally cared for with the gun and ammunition mules.

In India, on active service, the first reserve of small-arm ammunition is carried on camels or mules, according to the nature of the service; and the remaining reserves by the Ordnance Department or Field Arsenal. The gun-ammunition, beyond that in the first line of waggons, is carried in the second line of waggons, for which, however, bullocks are not now kept up in time of peace, although reserves provide to a certain extent for emergencies. The remaining reserve gun ammunition is in charge of the Ordnance Department.

Before leaving this section of the subject, I would call your attention to the fact that the system of *etappen* organisation, now so familiarised to us, has long been exemplified in Indian operations, and in the maintenance of the lines of communication with the base.

I fear that I have already trespassed too long on your patience, but I will ask you to allow me to pass in review certain points, without which my attempt to describe the Indian system would be still more incomplete than it is.

The evidence of the operations during the Mutiny, and of the expeditions which have taken place since that time, stands out as proof of the executive and administrative ability of Indian Commissariat Officers in war as well as in peace. The administration of the Commissariat Department is left entirely to the Commissary-General, through whom all propositions for change in interior economy are submitted to Government. The duties of an Indian Commissariat Officer are varied, and, I believe, educate him to that responsibility which he is frequently called upon to take. If I may be permitted to name the defects, I should say that, in common with all administrations and armies ruled by a central authority, there is too great a tendency to over-regulations and the multiplication of returns. Nor is this evil productive of only extra work. The current work in Indian Departments is so great, that reforms are difficult to effect by the heads of departments, who should be the officials to initiate and carry them out.

In the *Ordnance Department* we may say that it would be desirable to appoint to it Officers who had passed through scientific courses in England; and that there is great difficulty in India in obtaining scientific information. It must be remembered, however, how great has been the trial of the Indian Ordnance Departments during and subsequent to the Mutiny. The changes in organisation and in *matériel* have been very great. Large accumulations of old stores have had to be used up, and naturally enough Officers coming from England, ignorant of this fact, dislike to use these old pattern equipments. Commissaries of Ordnance soon acquire a knowledge of those stores which are not peculiar to their own service, and the choice of subordinates from all branches of the Service gives a good field of selection for the various classes of work.

In speaking of *transport*, we must all agree in the necessity for an efficient system of this moving principle of military administration. But the fact that it is financially impossible to keep up a gigantic transport train in time of peace, must go hand-in-hand with the first statement. It is an accepted military axiom, that we must have the nucleus and framework in time of peace, which in time of war may admit of expansion. It appears to me, though I feel I ought to submit the opinion with great deference, that in the Indian Commissariat Department resides the natural framework of an Indian transport system.

The officers of that Department are trained to a knowledge of cattle of all kinds. They are brought into daily intercourse with natives who must always form the main bulk of the *personnel* of Indian transport; they are acquainted with all the various gear and equipments required in transport. Their department is that which involves the greatest use of transport in time of peace; in a word, their duties in peace contribute to their efficiency in war.

But, having said so much, I should be far from wishing you to believe that the present Indian transport system admitted of no improvement. In the first place, the "moveable columns" require the frequent exercise which is insisted upon in a letter from the Secretary to the Government of India to the Adjutant-General, and which is published at p. 166 of the evidence before Lord Strathnairn's Committee, Report on Supply and Transport. To use the words of that letter, these columns "should be exercised so as to enable Commanding Officers and others to become personally acquainted with the actual requirements of moveable columns, and so that in times of tranquillity these columns may become so accustomed to move that, when required to turn out under the sudden call of duty to quell any disturbance, every one may know his place and clearly comprehend what he has to do, so that confusion and disorder may thereby be avoided."

The want of a more military organisation in Indian transport trains has formed the theme upon which successive Commanders-in-Chief have enlarged; and in Napier's "Administration of Scinde" will be found a vivid and picturesque account of the difficulties of marching with the huge and comparatively untrained "impedimenta" of Indian forces.

But although the difficulty is to a great extent financial, I believe that it might be overcome by giving the present transport a somewhat more military character, but distinctly retaining it under the Commissariat Department. An experiment might be locally tried in establishing a regimental system of transport for very light field equipment, by supplying materials for carts from the old stores of the Ordnance Department, and employing those bullocks which are used by a regiment in cantonments. Regimental Officers and men might be encouraged to qualify themselves in supply and transport duties, with the knowledge that they would probably be selected to fill in the framework of supply and transport when an expedition or war necessitated a sudden expansion of the nucleus possessed by the Commissariat Department. Under the present system it is an undoubted evil that Officers and men are often selected who are not previously trained to these important duties.

The expeditions of Huzara and Lushai have taught us how British and native troops can march and fight, without tents and with baggage restricted to an absolute minimum. While, therefore, we may agree that the scale of the "moveable column" baggage is somewhat excessive, according to our later experiences, we must remember that it would be madness to attempt to take the field in the hot weather in India without the shelter and requisites which are not military necessities in a good climate.

The triple nature of the Indian Departments is a patent evil, but this is too great a subject to be entered upon here. On the other side, the supply administration of India, if we set aside Presidential distinctions, seems to possess many advantages of simplicity, in that all *munitions de guerre* are under the Ordnance Department, and all *munitions de bouche* under the Commissariat.

Before releasing you from your kind attention to this lengthy paper, I desire to state that time did not permit me to obtain information from India on several points connected with this subject, nor have I been able to correct up to date certain minor details of Indian Transport by official information. I have, however, to express my acknowledgments to Sir Thomas Pears for having permitted me to look over general orders, &c., which have been published since I left India; and I must further thank Col. Dickens, C.B., who was Chief Commissariat Officer in the Huzara Expedition and at the late Camp of Exercise at Delhi, and also Major Colley, Professor of Military Administration at the Staff College; for several valuable suggestions.

In conclusion, I think we must all agree in the necessity for the study of military administration by Officers of the Army. Indian experience seems to point to the conclusion that if military men be properly trained they are equally capable of dealing with finance and supply as are civilians, and equally careful of the interests of the State. Whether the so-called civil administration of the Army is governed by civilians or by military men, we must all unite in believing that ignorance of Officers of the Army in matters of finance and supply leads to incessant friction between the Army and its departments. We, who belong to what is sometimes termed the combatant branch of the Army, are too apt to throw aside ideas of finance. The Army consequently divides itself into two great parties; the so-called combatant branch looking upon the supply departments as some mysterious and sinister element in Army administration, constantly thwarting the former's just ideas of efficiency, while the so-called civil administration looks on military men proper as a class constituted to be checked and controlled, and always desiring more than they are entitled to.

I think we soldiers should think more of the State, though not less of the Army; that we should try and understand that departments of supply are bound and financially sub-divided by estimates; that Government is not an inexhaustible purse-holder, only intent upon miserly economies; and that while those acts of Government which press upon individuals are continually thrust before the public, we may never know the thousands of times when the individual gets the benefit of a doubt or is the recipient of a wise liberality.

It may be called an Utopian idea, but I trust the day may not be so remote when Generals in command of tactical and administrative units, whether in India or England, shall have the power and responsibility of all administration.

That Army-corps system, of which Colonel Chesney and others have taught us so much, which has enabled Prussia to mount far up the ladder of military perfection, is no sudden invention. It was recommended 13 years ago for the Army of Bengal by His Royal Highness the Field Marshal Commanding-in-Chief; it has been advised to be applied to all India by Lord Sandhurst when Commander-in-Chief in Bombay and in India; and it is that which recommends itself to every mind desirous of improving the organisation of the Armies of the British Empire.

Those who are accused of desiring to Prussianize the British Army may console themselves by the reflection that a time may come when their successful efforts to take what is good in a continental system, and throw upon it the light of our own experience, may be acknowledged by a nation retrieved from possible disaster, either on its own shores, or in the distant but glorious Empire we have founded in India.

The Chairman: Gentlemen, it is impossible to deny the great interest in the matter brought before us by Mr. Collen. I now invite gentlemen to make any remarks that they may think the subject deserves.

General Sir William Codrington: I do not know much on the question of "Transport in India," but I hope other gentlemen, who know more about the subject, will give us their remarks, which will be of great interest. There is one point I should like to ask about, viz., the transport of ordnance stores. I understand that there is a totally separate establishment for the transport of the so-called warlike stores, as distinguished from those of food and fuel. Do they keep an entirely separate establishment for that, and a separate arrangement for replacing horses and carts for the ordnance supply? Of course it is a very large question, which one not so intimately mixed up with Indian as with English transport can fairly deal with; but I dare say there are many gentlemen who can answer my question; or at all events the Lecturer will afterwards.

Lieutenant-Colonel Hunter: I can only say myself, having been on the quartermaster-general's staff for many years, that for any transport in India the Commissariat staff is required. It does not matter what particular department requires transport, the Commissariat Officers are requested to supply it; and they on all occasions do supply it.

The Chairman: As it appears none of you are willing to enter upon further discussion on the very interesting matters which have been brought before us by Mr. Collen, I would venture, as one who has had very considerable experience of India, and as one who is under the greatest possible obligations to the department by which the armies of India are administered, to say that it is impossible to exaggerate the benefits imparted to those armies by the department to which our attention has been drawn this evening. I will not confine your attention simply to the small operations which have been alluded to by the Lecturer, namely, that little campaign of Huzara, which was organised when I was in command of the armies of India in 1868, and the late expedition in the Lushai country, which seems, as far as I can judge from the reports, to have been admirably done. At all events, it is on a small scale. But I will draw on my experience from my observations of campaigns conducted on a very large scale by some of the Commanders-in-Chief, who preceded me in the command of the armies of India. I would refer to the campaigns which were conducted by Lord Gough, also to those conducted by Lord Clyde. During all those campaigns, and in the midst of the vast and extended operations that were conducted, I will say this, that having a personal experience of what was done, it never happened that a soldier wanted his ration, or that a horse died from want of food. When you consider over what a vast area those operations extended, what were the difficulties with which the Commissariat Department had to contend, I venture to say that there are no establishments in any other country, and there is no department in any army, either in Europe or in any other part of the world, which is able to make a boast of that kind, and with perfect truth, to which I have drawn attention, as regards the Commissariat of the armies of India. Whilst it was my duty on various occasions to call attention to these facts, and to place them on official record, and as one who has been Commander-in-Chief in India, and who as chief of the staff under the late Lord Clyde, had to pay the greatest attention to the details, according to which those armies were supplied, I venture to say that it is impossible that the excellence of that department can be exceeded. And when the gentleman who has favoured us this evening dwells upon the necessity of what is called a greater military development, I think we should pause before we interfere with the system which has worked so well. I have it in my recollection that in one of the great campaigns of Lord Gough, it was much feared that the Army would not be able to advance and to perform the duties required of it by the Commander-in-Chief, because of an apprehended failure of supplies. Well, what happened? The Commissary-General of that day, General Ramsay, was in the most intimate connection with the great contractors of the country. One whose name was very familiar 20 years ago to men who served in India, Jotee Persjad, though not known in England, was able to come to our assistance; and by the exertions of that great contractor, the Army was able to advance and to perform its duties in a manner which amply redeemed the reputation of the Commander-in-Chief, and obviated even the slightest delay in the operations. Now, that is in exact conformity with the principle which was lately laid down by General Trochu in that admirable pamphlet which he wrote three or four years ago, about the reforms required for the French Army. He there pointed out that if any French Army were to continue to rely entirely upon a military organisation of supply, it would be very likely to fall into that kind of weakness which results from purely departmental management, as distinguished from availing itself of the national resources of the country. If you depend entirely upon a military organisation, you restrict yourselves, as it were, to the skeleton of supply. But if that organisation is so formed that you are connected with the great contractors, with all those civil elements of supply, which form not merely the skeleton, but the flesh and blood of a country, then an Army is sure to be supplied, and the operations are tolerably sure to succeed. This is the reason why I, as Commander-in-Chief, invariably opposed a radical change in the formation of the Commissariat Department of India. I considered it absolutely necessary that we should rest on the principle that the military department of the commissariat should gather within its folds all the resources of the country; and that if you went for a too military organisation, you would then cease to command all those resources which, happily, have been at our disposal hitherto. Well, the result of that was seen in the most remarkable manner in the operations conducted, first, by Sir Henry Havelock and General Outram, and afterwards by Lord Clyde, in the campaign of 1857. At that time we, literally, over many hundreds of miles, merely commanded the lines of communication between Calcutta and the seat of war. That is to say, we had command of the road, and we had command of the river; we could not go five miles, either from road or river, without going through the business of a military operation. Notwithstanding those difficulties, notwithstanding the fact that a country which for a hundred years before had been just as peaceable as the county of Middlesex, notwithstanding that country suddenly became absolutely hostile, and that every man for the time being was against us, as far as they could show their hostility, still such was the influence of the native contractors who worked under the Commissariat Officers, that the supply of the Army went on just as if we commanded the country as well as the roads. That would be quite impossible if we had not had that complete network of civil communication with the military department of the commissariat. Therefore I think that it would be dangerous to interfere with the form and the action of a department which has worked so well. With regard to the question put by my gallant friend, Sir William Codrington, I would mention that the ordnance supply of transport, to the best of my recollection, is drawn from the commissariat for purposes of war, and for the purpose of movement of the troops and field batteries from one station to another, just as it is done for other branches of the service. As was explained by the Lecturer, I think the siege trains are maintained by the Ordnance Department. Those siege trains include a certain number of bullocks. I believe that in time of peace their numbers are not kept up to the full quota, as is required in time of war. Still there are always siege trains in a certain stage of preparation, which are ready to move at a very short notice indeed. With respect to the supply of horses, which I think was also included in Sir William Codrington's question, that is an affair which is regulated in different ways in the several Presidencies. In the Presidency of Bombay we depend entirely upon the purchase of horses, which are principally Arabs and Persians, that come from the Persian gulf.

Sir WILLIAM CODRINGTON: I meant transport horses; the horses for transport of the *matériel* of war.

The CHAIRMAN: I will treat of that in a moment. The horses in Madras are supplied by purchase in the same manner from north of the Persian Gulf, and partly from Australia; and also they have a depôt of horses, where the latter are maintained for a certain time before they are distributed among the troops. The great army of Bengal depends for its horses upon the studs, where the horses are bred at great expense to the country; and also on the importation from Australia. With respect to transport horses, there are no such things in India, if we except the horses that are attached to the carriages belonging to the guns. All the transport in India depends, as was explained by the Lecturer, upon other animals. There are elephants, camels, and bullocks, and in mountainous countries we have mules; and there are dooly bearers, and different kinds of men of that sort. But horses are not used in India for the purpose of transport, as they are in Europe. There was a point which was mentioned by the Lecturer, bearing reference to the concentration of arsenals. When I first went to India, there was a great number of arsenals and magazines. As the system of railways came to be developed, very many of the smaller arsenals and magazines were abolished; and, as was pointed out by the Lecturer, the large arsenals —they are not new—have been very much developed at certain strategical points, the smaller ones having been all swept away. This, of course, is a matter of military convenience, and also of safety in case of a general insurrection. It is a necessary precaution, which was not possible as long as we had a great number of native powers who maintained separate armies, and were likely to go to war with us. Now-a-days those armies have mostly disappeared; the native powers have ceased to have any consequence whatever. In addition to that, our system of railway communication enables us to do with half-a-dozen arsenals for all India; whereas in former days the want of roads impeded such concentration. The moveable columns have been admirably treated of by the Lecturer; I can only say they are a modern feature in the Indian armies. They spring from our experience of the danger of leaving the district in which the country is divided, without means of moving a single soldier at 24 hours' notice, which was the case before 1857. These columns were formed, in consequence, to meet that difficulty. They have answered their purpose extremely well; but it must not be supposed that the means exist of concentrating those columns, to form the carriage of a *corps d'armée*, which might, perhaps, have been gathered from a sentence that met my ear in the lecture. The truth is that these columns, as shown by the Lecturer, are distributed over a vast area of country, and their concentration is impossible. It is very unlikely indeed, we should ever have again to assemble a large army in any part of India. Where there is a railway terminus, we should, to meet the wants of such an army, generally have to depend upon such carriage as the district of the country could afford where that terminus might happen to be. But we must guard ourselves from believing that the moveable column carriage would be of much service for that purpose, because the moveable column carriage is essentially an affair of local character, that is to say, that each station of some importance has its own column of transport, which cannot be alienated from it, except for the purpose mentioned in the lecture, namely, for aiding the civil power and carrying out the ordinary reliefs. I think I have no further remarks to make; but I would beg to offer the thanks of the meeting for the very excellent lecture to which we have listened. I may from my own personal knowledge bear witness to the exceeding exactness of the details with which we have been favoured. I do not think it is possible that we could have listened to a clearer narrative of the system that prevails, and of the advantages which are drawn from it.

LECTURE.

Wednesday, June 19th, 1872.

Lieutenant-General the Hon. Sir JAMES LINDSAY, K.C.M.G.,
Inspector-General of Reserve Forces, in the Chair.

AUTUMN MANŒUVRES ABROAD AND AT HOME, 1869—1871.

By General Sir William J. Codrington, G.C.B., &c.

The Chairman: General Sir William Codrington requires no introduction from me to the members of this Institution, nor to those who are in the habit of attending the lectures here. The information which he will give on the subject of "autumn manœuvres"—which are now engaging so much attention—will, from his knowledge of those he saw in France and in Prussia, as well as those he has seen in England, be, I am sure, of a practical character.

Sir William Codrington: The following remarks relating to "Manœuvres Abroad," are founded upon notes made at the Camp at Châlons, in August, 1869, and at the Prussian manœuvres in September of the same year.

The remarks on "Manœuvres at Home," are founded upon notes made in 1871, during the movements in the neighbourhood of Aldershot.

In the year 1857 I attended unofficially the manœuvres of a French corps at Châlons, of about 20,000 men, as well as those of the Hanoverian Army, forming, with the contingents of Brunswick and Mecklenburg, &c., the 10th corps of the then German Confederation, amounting to about 25,000 men. There were 68 foreign Officers present at these German manœuvres. In Hanover, in France, and in Prussia, an active and hearty kindness has enabled English Officers to take part in the manœuvres; an example long given to, and last year happily followed by, this country towards foreign Officers, with sufficient liberality and success to justify a hope for its continuance.

The principles of strategy form a subject scarcely to be dealt with in notes on manœuvres, or in an hour's lecture at this Institution. The following remarks refer more to details of tactics and equipment;

they may to some be without interest, or appear trivial; but to those of my own profession excuse is unnecessary. As no principle of strategy, no consideration of tactics, can be too high for thought, so in ours, the most practical of all arts, no detail can be too small for that attention without which even strategy might fail; for its combinations may depend upon the soldier's shoe, the farrier's supply of nails, the dampness of powder, or the absence of cartridges at the decisive moment.

From these notes I have now omitted details relating to electric telegraphs, and remarks not strictly on military points; but in the remainder no material change has been made, either in their substance or wording, since the time when, by order, they became the subject of official report.

Camp of Châlons, August 15, 1869.—The défilé of the troops then took place, about 20,000 men. The infantry marched past first: a very good precedence over cavalry and artillery for many reasons. It is well known that in the French movements and even parades, there is no minute attention paid to the regularity and dressing of companies; each general of division and brigade gave the sort of signal cry of "Vive "l'Empereur," "Vive l'Impératrice," "Vive le Prince Impérial," as he passed the saluting point, and each company by its commander did the same as it passed in a quick but loose order of marching. The knapsack is of the usual brown cowhide, with the hair on—a serviceable material. The great coat was carried rolled round it, in which position it drags less against the shoulders than it does with us when folded at the back of the knapsack; a tin water bottle covered with grey cloth, more handy to carry than our large round wooden one; a small mess tin made in one piece of iron, and tinned without any soldered joints; a tunic, and the loose trouser of good red madder dye; a low shoe, well nailed, with a white linen gaiter, these form the outside dress and equipment of the French soldier for parade.

Certainly the strap of a gaiter may wear out, but it is broad, strong, and easily repaired; and a low shoe (compared to our English ankle boot) is cheaper, better for marching, can be put down at heel in case of blister, and thus enable a man to limp on with his battalion. But every soldier should be able, by a light strap, to tie in his loose trouser under the knee; for nothing facilitates walking, or hard working, particularly in wet and dirt, more than thus taking the weight off the knee.

The general appearance of movement of the men of the line is an easy activity, which we should probably call a looseness of marching, the swinging the arm seeming to help them as it does Spanish and Russian troops, and giving an apparent energy and freedom which is wanting when the arm is held stiff down the side.

The men were in the formation of two deep, had Chassepôt breechloaders, with sword-bayonet. They carry a ball bag with 10 rounds, a small pouch with (probably) 30 rounds, and the rest in the knapsack; this latter is a questionable place for it. There is one battalion of Chasseurs to each division; Officers and men selected for activity, endurance, &c.; but such selection is like taking cream from milk, though it may have its advantages occasionally. About 40 battalions marched past, some few being "Infanterie de Marine," some Engineer companies. From dust and other circumstances I could not then judge of the real size and apppearance of cavalry and artillery horses, which passed at a trot. The "artillerie montée," or field batteries, mount two men on the limber, and four men on the waggon, none marching on foot, but they carry their knapsacks and a carbine slung across the body. The cavalry at the end of the défilé formed into line opposite, and charged up to us, keeping good line, but at no great pace. This terminated the parade. The artillery horses are harnessed, not with the collar, but with the *bricole*, or breast-band. It is certainly simple, inexpensive, and does not get out of order; but probably the collar is a more efficient means of applying the power of a horse to heavy work. The cavalry have also for their equipment a light breast-band, which can be turned to advantage in assisting artillery in difficulty.

August 16, 1869.—The Prince Imperial and all the Staff went on horseback round the camp. First to the cavalry horses picketed to a ground-rope, and by one fore-foot only; not so powerful or so good-looking as our own.

Then to the artillery; horses picketed to a rope breast-high, and fastened by the head. Not much show in the horses, which neither in power nor breeding can be compared to those of our own artillery; they have only four horses to each gun, which may be sufficient for peace, and this firm ground; they use the pole, not shafts. There is not much difference between the horses of the "artillerie à cheval," and the "artillerie montée" in this camp; the horse artillery gun detachments are of course mounted; they march past in rear of their guns.

Then to the infantry lines. There are permanent huts for one division; they are good-looking, and apparently well-built; timber frames filled in with a nice-looking reddish-coloured brick, good roofs of slate, and projecting eaves. The huts for Officers and men seem to be alike in size; the sergeants live and cook and eat entirely separate from the men, nor is there any social intimacy even between sergeants and corporals; they all mess in separate ranks, with a decided demarcation. In camp the Officers have general messes together; but in garrison towns they mess together only with their own ranks, and without an established mess.

The majority of the troops are under canvas; the tent is a bell tent, to hold 15, but now with 12 men, a centre pole, and means of ventilation at the top; but there is scarcely any wall to the tent, though there are two sets of tent-pegs, one at the ground, the other with the stretching lines. The tent is low, but with a larger circumference than ours. I doubt its being as convenient for the men, in consequence of the low wall; there are two openings, one a triangular door, as with us; the other can turn up, supported by two poles, making a convenient door.

The men of the infantry of the line were small, but able-bodied and active, many of them young-looking, arising from their time of conscription; the Chasseur battalions, being selected, are firmer looking. There were some Crimean regiments, but few of the men had the medal, though a certain number of company Officers wore it; the Officers commanding battalions and brigades seemed younger in proportion than the company Officers.

Frequently the *drapeau* was placed horizontally across two sets of piled arms. The arms of a company are piled together under a covering small tent on the alignment of each company, and it is called a "manteau d'armes." This is a better arrangement for peace than for service.

The soldier has two meals, and similar ones, per day; the first with soup, bread, and meat at 9 or 9.30 a.m., the second at 5·30 p.m.

August 17, 1869.—On our return to camp we went into some new storehouses, to be increased, well built in a similar style to the huts, though of course larger. They contain carriages for the train, ambulances, cacolets, litiéres, pack-saddles, &c., the commencement of a store establishment for a considerable army supply on this, an important strategical point for France. For Officers' baggage, a two-wheeled one-horse cart, two such carts to each battalion. Each Officer will now be required to purchase one of the boxes which is fitted in with others; a canteen box also among several. This will be the official limit to Officers' baggage. I saw a similar arrangement with the Sardinian Army in the Crimea.

Water is found all over the ground of this camp at a level of 10 or 12 to 20 or 30 feet below the surface, according to hills and depressions. It was the first and principal consideration in recommending the purchase of the ground that the supply should not depend on the small stream at Mourmelon, or any other running water, but upon wells. And having made many successful trials in finding water in all parts by boring, it was recommended for a camp and exercise ground.

At half-past two, manœuvres of the troops. The Government ground is a space enclosed by sides, each of which may be roughly estimated at three leagues; chalk soil, dry to a degree, and healthy, a sort of inferior sparse grass growing upon it showing the chalk through, hard, excellent and easy for all arms to march over. It is a gently undulating surface with long slopes, nowhere steep, though sufficient to hide large bodies of troops. There are a few pine woods, the trees small in size, and some stunted pines in long rows here and there. One might see all the manœuvres, and accompany them, in a calèche.

The manœuvres took place about three or four miles from the head-quarter pavilions. The idea given by General Bourbaki was, that an army coming from the east had obtained possession of the long line of height which overlooks the undulations towards the camp, and had also seized a wood and ground in advance of his left front, by which the junction of one of the three defending divisions was endangered. This detached division was to attack the wood and manœuvre to its left to join the main body. When the junction was secured, a general attack by the three divisions united was to be made on the enemy's front, whilst cavalry and horse artillery turned his right.

The movements were undertaken in this view of course without difficulty. Judging from our central position, the troops were extended over a large space, and with considerable intervals between regiments.

The infantry were in the formation of two deep, with skirmishers in front, and generally attacked in line, though some were in the usual double column of pelotons. When the detached division had secured part of the wood and its new communication, it passed to its left in rear of the other divisions, which were ordered during this movement to make the general attack, orders being also sent to the distant cavalry to turn the enemy's right. The attacks were made partly in line two deep, skirmishers in front, and partly in column. The troops moved actively, but, as we should say, loosely, as is their habit; and we should insist upon the prudence of having less intervals of space between regiments. Sometimes the skirmishers and supports were formed from regiments, sometimes from the battalion of Chasseurs. The firing was principally *à volonté* (file firing) but occasionally by companies. The cavalry movement on the left was so distant that we could only see a small cloud of dust created as we moved in advance. The attack, therefore, was extended over a large space of ground for such an operation by about 17,000 or 18,000 men. It is certainly good hard marching ground, but the troops had come some distance from camp; they moved actively during the manœuvres; they had a considerable march home. It is scarcely necessary to say of any portion of the French Army that it marched with soldier-like activity and efficiency. The French soldier on march, such as this day, wears his small shako, his capote or long great coat, of which the front skirts are turned back for ease of movement, his red pantaloons tucked inside the white gaiter which comes some way above the ankle. The tunic is in the knapsack, the *tente d'abri* round it, with the sticks to support it cut in half, and placed up and down the side of the pack. The firing with the Chassepôt was of course quick. A certain few ramrods were used to put out of the breech a failing cartridge, but I did not see many of these. I did not see any other battalion movements than an occasional forming line and column in their usual manner on the front of two centre companies or pelotons. It has always been their habit to attack with a large body of skirmishers, and I imagine they will strengthen that system in future.

Each Division General has his distinctive "fanion," or colour (camp colours in size), carried by one out of five or six cavalry orderlies. Here one was red, one blue, one yellow.

August 18, 1869.—On horseback, to see rifle and artillery practice. The targets and butts are about two or three miles off, with interminable power of range, there being no population or houses; but the line of artillery fire is kept clear on a broad space by mounted men. The first practice was with the Chassepôt by 200 men, two deep, firing at a continuous canvas target of about their own length of front, and at 200 mêtres another target, behind it, at an interval of 100 mêtres, and two other similar targets with 100 mêtres interval—in all 500 mêtres. It was supposed to show the men that even if they missed the first line their fire would be effective against troops in rear. The targets, being continuous, were well riddled in the three or four minutes firing *à volonté*, and there were were many shots in the further targets, of course, for rifle shots going through the first went also through others, as all were of canvas. There was also some battalion firing at 800 mêtres, powerful fire. But the best experimental practice was the skirmishing of a battalion of Chasseurs in marching order at a long line of separated single and double targets at 800 mêtres; then, after advance, at 600 or 700 mêtres; then again, after similar advance, at the double; then, after retiring at a good double, at various distances. I do not know the proportions of hits, but this open formation of a battalion of Chasseurs, yet with ease of closing files if necessary, makes a very formidable means of attack, for they were not employed strictly *en tirailleur*, loose and extended, but I presume their closer order and good alignment was intentional for its particular purpose. (I understood the hits to be one-fourth, or 25 per cent.) The next experiment was to show the possible effect of a fire of infantry upon troops assembled as a reserve inside a redoubt, and not under the immediate cover of a parapet. Nothing could be seen from the firing detachment at 800 mêtres distant, except the white chalk low earthwork; but canvas screens in two rows were set up in the interior, one at about 10 yards, the next parallel to it at about 15 yards from the parapet. The firing from about 200 men took place against it, the sighting of the rifle to be 1 millimêtre above the crest.

The targets were not very much hit, nearly as many in the second, as in the first target; but enough to do damage and to shake *morale*, though in reality, men defending such a work would have been close under the parapet and out of fire. I saw the rapidity of the Chassepôt tested by the Officer Instructor firing 17 in the minute—the cartridges, however, were ready loose in a man's hand at his elbow. It is lighter than the Snider; it has a sword-bayonet which makes it, when fixed, heavy at the wrong end, but the French, as we ourselves now, do not habitually fire as formerly, with a fixed bayonet or sword.

We then saw shot-practice by the artillery; 10 guns of "batterie "de réserve, pièces de douze," brass guns weighing 11 cwt. English, the shot weighing 24 or 25 lbs. English; rifled guns, elongated shot with brass studs. It is a hollow shot when stopped as now with a lead plug; or a shell, with a brass screwed-in fuze. The practice was a known distance of 1,200 mêtres. The firing was short, and they had to increase the elevation to that for 1,500 or even 1,600 mêtres in consequence, it was said, of the "rayures" being very much worn from age. The fuze is a brass fuze, both for these pieces and the field "pièce de quatre." It seems it can be bored only for four distances, and does not seem so advantageous as the Boxer wood fuze.

We then went to a line of 10 or 12 guns, field batteries and horse artillery with "pièces de quatre," *i.e.*, 8 lbs. weight of shot. They fired shrapnel, but they mostly burst much too high for troops; the range being 1,200 mêtres, the artillery Officers seemed to think that it was more fitting for the "pièces de 12" than these field guns. Want of time prevented our seeing an experiment of interest—that of using field pieces with very small charges and given a high elevation in order to damage artillery in works by a sort of perpendicular fire of shell. The dummy guns and detachments were put up inside a gabioned fieldwork which we passed; but to the disappointment of the artillery, who had been long there, and of ourselves, the experiment was not made.

August 27, 1869.—At Frankfort I had the opportunity of visiting the camp and bivouac of some Prussian troops. Four guns, a battery on peace establishment (the war complement being six guns) attached to a brigade, had just come in from a supposed " alerte." The gun and limber had its six horses: no waggons. Three men sit on the limber box and two men on the carriage of the gun itself, one on each side of the gun, and protected by a bent iron rod, as it may be termed, between the wheel and the gun, a leather seat on the axle, and a small support for the feet; very little space, and must be considerably knocked about.

A Non-commissioned Officer is mounted, and these five men work the gun, which is a breechloader of steel with rifle grooves similar to the Armstrong, the breech closed by a close fitting cylinder passing through it horizontally. The gun seems limbered up to a pin or crutch attached to a continuation of the pole passing under the limber. The guns were left as they came in, limber to the front, and the horses were placed in a line in front at the side of the limber, enclosed by a rope from limber to limber, and tethered by the head. They seemed thus to be placed handy for their purpose. The gun seemed about the same bore, but heavier than the Armstrong.

The horses with very long traces, serviceable animals, but not the size or power of our own. The wheel of the gun-carriage about the height of ours, being higher than the French; the wheel of the limber considerably smaller than that of the gun; the nave of the wheel is iron, the spokes of wood, with a continuous tire, and the Officer said that a damaged spoke could be taken out and replaced by unscrewing at the felloes. Went also to the bivouac of a cavalry regiment, the 5th Dragoons. The question of sore backs was made an important one by the Commanding Officer, as with other cavalry Officers; and he mentioned with pride that although his regiment with five squadrons had been out some time in drills and manœuvres, he had no sore-backed horse. The saddle is composed, as with us, of the two shaped out sides of the tree, wood; and then the usual blanket next to the horse. Some of the trees had straw laid lengthways along the tree, and sewed to it as a flat mat of its size and shape, and about half an inch thick. Then being cut out, chamfered out at any particular place, it eased that part of the back on the least commencement of swelling or irritation, the object of all his orders and inspections being to insist upon the least beginning of inflammation being made known in its earliest stage. It seems a simple way of prevention or remedy. The man's kit is carried in holster bags, no valise, the cloak rolled behind the saddle. The horses passed going to water: a horse of good size, but better in fore quarters than in hind, where he was somewhat lanky and unknit. I then went to the infantry. The regiment is of three battalions, and was divided, as usual in the Prussian Service in the field, into three parts, the " gros " being the main body, throwing out to its front " vorposten," and having also a rear guard. The battalion on halting, piles arms in column, close column, or something similar. Then each company is moved out on its alignment to the right or left to put down their knapsacks, each man subsequently using his own for a pillow as he lies amongst the straw which is served out to them almost in profusion—as indeed one may say of the logs of firewood. A certain portion of the straw is twisted or plaited into a broad band and somehow wove into the upper part of the sheaves of straw; the whole then stands up, forming a hedge of a square or a circular form, enclosing the rest of the loose straw which the men lie upon. The wood and straw brought by farmers' carts is resold by the Commissariat on the troops quitting. The cooking was going on: the soldier carries his tin can—a larger one than either French or English—perhaps unnecessarily large—placed across the top of his knapsack. They carry no company tins for six men as we and the French do, nor indeed can these be depended on for service. The usual small trench was made for the fire, each company cooking for themselves. When near a village they borrow, if possible, a large cauldron in which they make a general soup and meat hodge-podge. After assembly for roll call, the band of the regiment played a hymn prayer, the men remaining uncovered; and each regiment did the same in various parts of the camp bivouac.

Monday, August 30, 1869.—To the parade of the Corps of the Guard at Berlin. The troops were drawn up in two lines, infantry in contiguous columns in front, cavalry and artillery forming a second line. There were about 13,000 or 14,000 infantry; some two or three battalions were of older and more formed men, but many battalions were of younger though good sized men, but very few medals and old soldiers; those of 1866 and its campaign had lately left the ranks, having served their time, but there were many Officers with medals. The infantry go by first in all their parades, a very good plan for many good reasons; it was this infantry of the guard that had seized the village of Chlum in the centre of the Austrian line at Königrätz. A detachment of drumers, with some senior drum-major, was, during the whole défilé, placed opposite the saluting point, and on a battalion approaching gave the time, and continued beating until the battalion drums were near enough to fall into the same time and take it up; this seemed to prevent any hesitation in the step of the advancing battalion.

The men of the infantry marched past steadily and well, but with the curious show manner of putting out and bringing back the foot with a bent knee. It gives an artificial and affected look to troops that are not at all of this character. The time was about the same as ours, the firelock at the advance. The colour is carried by a sergeant, and singly, on the right flank of one of the companies.

There are battalions of chasseurs, selected men, and there was one battalion formed by a few Non-commissioned Officers and men from almost every regiment in the service, as a means on returning to their regiments of assimilating the marching and arrangements of the whole army.

The helmet with the spike at the top is the general head dress for the infantry—it must be heavy and uncomfortable; the men had their packs, generally of cowhide; the chasseurs had badger skin packs, one pouch, but on service two, one on each side towards the front. They had, of course, the needle-gun breech-loader with bayonet, for which they have no scabbard, therefore it is always fixed; they have a sword besides, but the chasseurs have simply the sword-bayonet and scabbard.

The cavalry came next, the Garde de Corps and Cuirassiers of the Guard, white uniform, helmet with eagle at the top, long black thigh boots; their horses are of good size, no brass or bright buckles about them, and the leather left its brown colour. They went steadily by, and looked very well. The lancers with black and white pennons the same, but the horses smaller and lighter. None of the cavalry horses as powerful as our own. The artillery came last, 4 guns to a battery in peace, 6 horses to a gun; on the limber of the field batteries 3 men, on the gun-carriage itself 2, as I have elsewhere described. They carry 42 rounds per gun without waggons. Horse artillery has a lighter steel gun, I believe an 8-pounder, but the denomination of their guns is understood to be neither simple nor good; the horses are serviceable but not equal to our own.

The men now in the ranks are young, from others having completed their active time last year and gone to the reserve; this accounts for the few medals in the rank and file.

The system of the Landwehr was formerly rather a deception as to efficiency, for it consisted of many men who had only served in the Landwehr itself; many were old, many incapable. Now, every one of the Landwehr must have done army service in the line. In exacting the personal conscription for the army, a man who is physically incapable is not let off entirely; he has to pay a "steuer" or tax, and it is considered properly so, for all others pay this heavy personal tax, therefore he must pay in money if he cannot in person. The object of the whole system is not only to make the nation military in fact, but to induce it to take an interest in being so.

August 31, 1869.—To Müncheberg, about 25 miles east of Berlin, to see the manœuvres of the third, or Brandenberg *corps d'armée.* About 18,000 men were posted in two lines, infantry in front in close columns of contiguous battalions, but with considerable intervals; cavalry and artillery in a second line. In the défilé which took place, infantry of course first, the men young, but able-bodied steady looking men. They marched past by companies in quick time well, with good steadiness and alignment, although with what might be called a "prancing" step. This manner of parade marching does not look really soldierlike. Though it is principally a matter of parade, such customs become sometimes identified with the feelings of soldiers, not lightly to be interfered with; but being a habit, possibly not a good one, I saw some advances over dry and dusty plough ground partake considerably of this habit. Blue tunic, black leather helmet, cowhide knapsack, hollowed out for the back, great coat carried across the shoulder and pack, one small pouch (a second added in war), the large tin can horizontal on the top of the pack, a small water-bottle and haversack, white trousers (part of a parade dress for the King), boots, a sword, the needle-gun with bayonet fixed, this was the dress and equipment of the infantry soldier. They went by also in line of contiguous close columns of regiments, *i.e.*, a front of three battalions, their colours in advance; they marched capitally, and columns always look well and powerful in such a movement. A very good parade show is formed when cavalry pass, by the Non-commissioned Officer or man with the kettle drum passing first in front, and alone, beating what I suppose is termed a "point of war," with a manner that would do credit to a French Tambour-Major, the trumpets coming in occasionally with a similar point of war. Five squadrons to a regiment, and strong ones, but little ornament of buckles, &c., about the harness, though some of the hussars had a long pointed and laced shabraque, which took away from the size of the horses, and must be an useless affair. The horses serviceable, but not large, the whole soldierlike, except those long shabraques. A corps is generally composed of 25 or 26 battalions of infantry, between 50 and 60 pieces of artillery, and 30 squadrons of cavalry; its infantry in peace is about 500 men per battalion, in war to be completed to 1,000, divided into four companies, the Captains commanding which are mounted.

The military arrangement of Prussia for conscription, quartering, drill, and manœuvre is by a division of the country into districts for *corps d'armée*, generally conterminous with the demarcation of provinces. Thus the 1st corps is raised, maintained, and localized in East Prussia; the 2nd corps in Pomerania, the 3rd corps in Brandenburg, &c. There are 12 such divisions and *corps d'armée*, besides that of Hesse, and the corps of the Guard. The preliminary drill of recruits, battalions, and brigades, and, finally, the assembly of each corps for the autumn manœuvres take place within the province itself, the men when manœuvring being quartered in villages or bivouacking in the open. Where a conscription is so large and general, this localizing the corps must have the advantage of interesting the families of the population in the well-being of the corps, and must render less irksome the quartering, the damage by manœuvring (which, however, is always paid for), and the conscription itself. It may, however, give some idea of the pressure of conscription, as well as the military power of one continental nation—to which others probably are not inferior—to remember that the army which England landed on the shores of the Crimea was 27,000 men; but that a number equal to at least *nine* such armies, complete in infantry, cavalry, artillery, and transport, without counting reserves, invaded Bohemia in separate corps in 1866. It was one of these corps, the 3rd, on its peace establishment, the manœuvre of which was carried out to-day. The orders were given, and their execution carried out, with quietness, decision, and promptitude. The country was generally quite open, with long, even undulations of plough and no fences. The general plan was an attack upon the village of Müncheberg, situated on the crest of a gradual slope, and with advances and retirements in the centre, according to supposed occupation of farm-houses by an enemy; at last to bring forward the whole right wing to turn the left of the enemy and throw him back beyond the chaussée marked by a line of trees.

The attack of Müncheberg began by an infantry brigade; skirmishers in advance about 1 or 2 paces between each file—rather close as skirmishers—supports in column of sections in rear very close to the skirmishers—and the portion of the battalion in column of companies—also very close to the supports; too much so, indeed; for if we suppose the village of Müncheberg occupied by infantry and guns, the artillery would have reached and decimated, at 12 or 1,500 yards, such concentrated marks as the section column and the battalion. The village and mill, or part of it, being supposed to be held by the attacking party, I rode to other parts of the field. Similar attacks by infantry not preceded by the fire of artillery, took place against some farms and gardens in the centre, *i.e.*, by skirmishers, occasionally reinforced from supports which remained close, and the battalions of companies also close, and running up, charging with fixed bayonets, in column. The artillery, generally in rear at considerable distance, and firing over the heads of advancing infantry—a somewhat dangerous practice—and, of course, the rear position prevents range being as effective as from a front position; but there was one occasion in the centre that I saw the horse artillery come well in front of the troops. The cavalry, consisting of 25 or more squadrons, were all massed on the right rear, moving to front or flank occasionally; they were well concealed in the early part of the day; but from the enemy's hill in front they had been seen and exposed to fire by the valleys running in a direction favourable to their being enfiladed. They moved, however, very steadily and well. Dust there was in plenty to obscure cavalry movements of detail; only one regiment, the Ziethen Hussars (in red), were brought forward to charge, and from others competent to judge, I heard that they were well in hand in everything. When the right of the infantry and a portion of the cavalry had thus come into the new alignment, there was a general advance, driving the enemy to the chaussée marked by the line of trees. I remained in the intervals and in rear of three battalions (small ones) advancing in actual line; they did so at a quick pace, drums beating; it was a steady good advance for a considerable distance over dusty plough, and uneven ground, but it was well done. Then the manœuvres ceased. The men did not look at all tired; dusty enough—but that is all.

The usual infantry formation is three deep, in order to take the third rank out as skirmishers. Thus the front of a company or a battalion is not diminished; and even if in three ranks, fire could be given with the front kneeling. The Jäger Battalions are formed two deep,—there is one to a corps. Several men in the ranks carry tools—one in ten—such as picks, spades, axes. There are no battalion pioneers in a body, as with us. The Prussian soldier has a boot up to the calf, the trouser over it; but in dirt the boot is outside; though we should not think it good for marching, yet it is the habit of the country, it is simple, and certainly keeps out stones and dirt. The fire of the infantry was given frequently by word of command to sections or companies, or to the battalions, and sometimes by file-firing—it was, of course, rapid as breech-loaders are—it seemed to require a considerable knock with the hand upon the projecting lever.

September 5. *At Stettin.*—To the parade and manœuvres of the 2nd corps (or Pomeranian Corps) which were to take place in the open country near Stargard, a town about 16 miles east of Stettin. Between fifty and sixty foreign Officers, twenty-one of them being English, attended these manœuvres; some few were sent officially, but all were recognized as the guests of His Majesty the King of Prussia. Nothing could exceed the liberal hospitality with which all were housed, either with private individuals, or when at the hotels, by the order and at the expense of the King. Upwards of forty carriages, each with its special number, were placed every day at Officers' disposal to ensure communication to and from the railway, their presence at official dinners, &c. On arrival at the manœuvre ground, 50 or 60 horses of the cavalry were ready for their use, and an Officer, Major Baron Korff, of the Dragoons of the Guard, was placed in charge of these arrangements, sending to us each evening in writing a detail of where and how and when we were to meet, and at what hour and where we were to assemble for dinner. Right well and agreeably was this duty done, and it was one that required attention to minute detail, good tact, and good temper.

September 6, 1869. *At Stargard.*—To the parade of the 2nd corps, 26 battalions of infantry, in a first line of contiguous close columns of about 500 men each; some of the battalions not quite such large men as the Corps of the Guard, but very good specimens of young able-bodied soldiers. The infantry in white trousers, being a parade for the King, but otherwise in real marching order. We rode down the line of infantry, and then down the second line, composed of cuirassiers in white uniform, dragoons in light blue, and lancers, in all 30 squadrons. In the same line 16 batteries of artillery. At the défilé the infantry again first, column of companies at 22 paces distance, ranks three deep. They marched very steadily and well, with less of that peculiar step which I have before mentioned.

They were subsequently marched by in contiguous columns of regiments (three battalions each), steadily and well, with a good firm step, firelocks at the advance. The wheel of battalions at the angle was quickly, but somewhat irregularly done, at the double. The horses of the cavalry about the same as those of the guard, perhaps not quite so good, having a raw look about the quarters. The artillery horses of this corps seemed to me as good as those of the guard; without being large or strong they were active and serviceable in appearance. But we must not say they could be compared to those of our own artillery.

September 7, 1869.—By train again from Stettin to Stargard. Yesterday was the parade inspection, to-day the manœuvring of the corps. A dusty drive, partly road, partly field, of three or four miles, brought us to our horses, and joining in with the head quarter staff in a canter across the open country, ascended a small height suddenly, and looked down upon the whole of the 2nd corps massed in its position in readiness for movement. The 18,000 or 20,000 men of infantry, cavalry, and artillery, were well placed and concealed from the country and the enemy against which they were to advance, the enemy being designated by merely a few infantry and cavalry in extended order, in a position about one mile and a-half distant. The order to attack having been given, the advanced guard was sent out, cavalry trotting up, and passing over the hill spread out like a fan to reconnoitre. Infantry and artillery were also sent forward, but no horse artillery. Then followed the main advance of the corps, with its infantry and artillery.

On this occasion the artillery were more used in advance or in line with the infantry. But still there was a habit, and rather a dangerous one, of firing over the heads of the advancing infantry. The same system of attack took place, skirmishers very close to each other, supports only about 15 or 20 yards in their rear in section columns, and the remainder of the battalion about the same distance from the supports, and in close column. The tirailleurs of the infantry of the line go to the front skirmishing with their bayonets fixed, because, having a sword, they have no scabbard for the bayonet.

The infantry constantly advanced against positions occupied by artillery, in column; and sometimes even deployed under immediate fire of artillery and infantry in position. This could scarcely be practised with impunity in war, nor could that of reforming the columns from line under fire for the purpose of retiring, which I occasionally saw done. But the attacking artillery, both field batteries and horse artillery, were well moved forward in masses, particularly on one occasion, when 20 guns were advanced to the crest of one of the long low hills and brought up the short steep pitch at a gallop. The guns had 6 horses, the limber carries 42 rounds, the men are carried on the limber and gun carriage, their knapsacks under the limber, and the men are thus ready at once to work the gun. There is something to be thought of in this different system from our own. The final attack today was upon the enemy's line, which had been strengthened by three or four redoubts in the plain, thrown up during previous engineering practice. The attacks were principally in columns of battalions closely preceded by skirmishers and supports. The company Officers and Non-commissioned Officers seemed during the whole day to be very attentive in regulating the detail of the men's movements in skirmishing, firing, &c., though here, as elsewhere, it is not easy to get men to act a reality when they see no reality of war.

The men marched well all day; some had come four or five miles from their cantonments to the rendezvous; the parade for manœuvre was about 9½ o'clock, the end of the movements about 3 P.M., the country principally arable in the ridges, as left by the plough, and the troops marched back to their cantonments. Scarcely any men fell out, and I passed several regiments on their march home moving regularly and actively.

September 9, 1869.—To the town of Stargard, and after a canter of a couple of miles came to the village of Schöneberg, which, with the rising ground near it, was to be seized by a south army, in which position it was to be attacked by a north army. The *corps d'armée* on these occasions is divided into two divisions to oppose each other, one side having always small green twigs of trees on their helmets to distinguish it from the other. To-day the north army had 14 battalions, 13 squadrons, and 32 guns; the south army had 11 battalions, 15 squadrons, and 28 guns. A general idea is given, by means of lithographed orders, to both the opposing armies; this comes from head quarters, and gives a strategical position of some larger forces of invasion, and of defence, from which the opposing divisions are detachments. Then there is given a "special idea" for each opposing army, which settles their position and the object of their movements, leaving to the two opposing Generals the strategical and tactical movements of their troops, by which they can take advantage one of the other, by rapidity, by occupation of ground, or the tactical use of the various arms in defence or attack. The decision as to where the advantage lies, what troops are to retire, and the prevention of too close an approach, is made by three superior Officers on the spot, who ride about together to all points of the field where a decision becomes necessary. They have a broad white band round the arm; their orders are obeyed at once, and they wear the sash as a mark of duty. Volley firing not to be within 250 paces, bayonet attacks not to be within 60 paces. The country was generally of the same easy plough undulations, entirely open, and no fences, but the hollow way of the Krampfehl gave a variety to the movements, though in crossing it from the north it was merely to feel for the enemy. This, the commencement of the day's manœuvring, was done with activity and apparent intelligence by detachments and single patrols of cavalry, who advanced quickly across country, observing and returning rapidly with information. Then the passage of the small gully and stream took place at various points by the north army, the movements principally in close columns of battalions, until they arrived in front of the southern outposts, when skirmishers were thrown out. The artillery seemed generally employed in positions to the rear of infantry, firing much over them, and frequently at very long range. The attack and defence, when near each other, took place as I have previously described, by skirmishers, close supports, and columns, and probably they would be much exposed in that formation to artillery fire, particularly in advancing towards a rising ground and village, such as Schöneberg, with its houses, fences, walls, and irregularities of ground. But supposing the formation the best for their purpose, the Officers of all ranks evidently take interest in seeing their men do their work properly. To-day was very hot, clear, and dusty; they moved very well throughout the day in marching order. No wonder that I saw one or two men lying as if dead, and that there are fallers out as in other armies; but the day was trying, some regiments had marched far to the ground, and I have seen many more men inefficient on such occasions elsewhere.

September 10, 1869.—To the same district as yesterday, that of Schöneberg. The northern army of yesterday was supposed to have forced the retreat of the south army from the Schöneberg position, which the north army now held to oppose the advance of the south army. The advanced posts of defence seemed well placed, cavalry detachment well concealed, artillery on a mound showing merely the muzzles of their guns; the horses and limbers well under the small advantageous crest. On the advance by the enemy, the reconnoitering by cavalry seemed well and actively carried out, though subsequently the enemy's artillery might have done them damage when in column;

nor, from some misunderstanding, did they retire till the enemy's skirmishers had long been firing upon them. But such accidental mistakes happen in all armies, more particularly when there is nothing to mark reality. The movements to-day were made more interesting by the intervention in the midst of the plain plough country, of one of those curious watercourses which form narrow but flat little valleys of grass with fringes of trees, and produce unsound marshy parts, impracticable for troops. They require a prompt reconnaissance, particularly by cavalry and artillery, previous to their passing them. All this gives admirable practice for General Officers, regimental Officers, and exploring parties. One of the decisive points of this day's manœuvre was the defence of a round fir wood standing on rising ground, with a deep, narrow drain or watercourse in the bottom within rifle range. Both were held at first by the defending party; but, of course, when the attacking skirmishers arrived near the drain, one party must go. So the defenders retired, although the attackers must have fared as badly in their open advance up to the drain, as the defenders must have done on retiring up the open slope to their wood. There was here distant artillery fire on both sides, battalions were moving about in columns; there was much musketry fire from a strengthened skirmisher-line, and by supports brought up for volley firing. At length battalions were got across this deep little watercourse, and went charging up the hill, with drums beating, and cheering, opposed in a similar manner by the defenders of the wood advancing their battalions and cheering. The Umpires were on the spot, and stopped closer advance; but, as soon as their backs were turned for another part of the field, a closer attack and nearer approach between the infantry took place with bayonets fixed, when some Officers of the Staff put a stop to further movements by galloping between them. There were many battalions in reserve for the defence of this ground, and there were many battalions ready for its attack, and I do not know how the matter was settled when the trumpets along both lines sounded the cessation. Although this was a shorter day, there was plenty of work for the troops, whose marching qualities and steadiness were very apparent, as well as the attention and intelligence with which their Officers directed them.

September 11, 1869.—The rendezvous to-day was at the old castle of Pansin, a place near the manœuvre ground of yesterday. The north army had retired, occupying the short and steep heights of the Klosterberg and the Heideberg, which commanded the valley and a deep drain close under their front where their outposts were placed. The attack of the south army began by infantry skirmishers with their supports, and the battalions approaching the position thus held on the Klosterberg and the hills near it: the steep, narrow ditch in the bottom being occupied, there was any quantity of firing at each other, the artillery of the defenders placed on the brows above the horses and limbers well concealed from fire. With various advances and retreats, it seemed considered too strong to be forced at that point, and I went to another part of the field where the passage of the attacking right wing was to be made. On the Heideberg, a good commanding rounded knoll, were placed one or two batteries in entrenchment which could search the ground, like a glacis, down to the wood and bridge on its flank, by which the attacking enemy was to pass. It did so pass, and in close columns, which in peace was easy, but in war could scarcely have been attempted by daylight under the guns of the Heideberg position. But having now passed without loss, it could advance and turn the position, which it did, by marching on between this stream and a long lake to its right. It was therefore supposed that the defenders remained too long on the Heideberg; but, if in real war this flank march were made in column under an enemy's guns, perhaps the attacking force would never have passed at all. After the defending army had retired its left wing, the two armies faced each other, with the usual firing by skirmishers and by battalions, rarely deployed into line, and the trumpets sounded the close.

Here, as elsewhere, the truth of the saying is apparent, that "there "is nothing so unlike a real battle as a sham one." It cannot be reality for companies or battalions to stand still and fire volleys at each other at 70 or 100 yards apart, or at the same distance from a village in possession of an enemy: it cannot be reality to see cavalry as well as infantry halting or moving quietly in column under the effective fire of batteries of artillery; nor can it be reality to see artillery with their limbers and horses, quietly firing, when an enemy's skirmishers are within 400 or 500 yards. Of course these practices are neither ordered by regulation, nor are they universal; but they were certainly frequent; they may possibly be inseparable from a system of opposing one set of troops to another in peace; but if carried out in war would get sharp correction from an enemy. On the other hand, there is a great advantage to all ranks and to all arms in the independent movement of troops in country which they pass over for the first time; the easy or difficult passes for cavalry and artillery have to be found out and acted upon at once, and the very marching of men over varying and unknown ground gives greater practice and utility to drill and manœuvre: and this practice is a reality and valuable in a high degree. The result is that troops march and work admirably.

September 12, 1869.—At Königsberg, East Prussia. In the Lutheran church here, as in many others in Prussia, there are placed on simple tablets on the walls the names of all Officers and soldiers who died in the War of Independence, 1813—15, and who belonged to the district or parish in which the church is placed. Every name was legible, and it was recorded that they died the death of honour.

September 13, 1869.—To the parade of the 1st or East Prussian *corps d'armée*. There were under arms 26 battalions, 25 squadrons, and artillery with 60 guns. The infantry seemed as stout and as fine men as the majority of the regiments of the Guard Corps; able-bodied good soldiers in appearance; their white parade trousers did not look serviceable, but they were in other respects in marching order. There was not so much of that peculiar and somewhat artificial manner of marching past, and they went by with good steadiness, dressing, and activity, with firelocks at the advance. But when they had thus passed the saluting point, it was rather a relief to the eye, and to themselves also, to see them with firelocks sloped and arms swinging, with a full paced natural step. A pontoon carriage and a trestle bridge carriage also passed. The cavalry horses looked rather stronger than those of the last corps we had seen. Cuirassiers in white uniforms with their cuirasses, a colour and an equipment that must have its disadvantages on service; but they looked well now, so did the dragoons with a good light blue uniform, without any nonsense about it, plain and well looking. The lancers with various facings, good uniform with serviceable horses; the hussars neat, good uniform, and handy horses, which would look all the better without the long pointed saddle cloth hanging low down on the horses' flank. The artillery horses looked in good order and condition after their being now for some time exercising and manœuvring. The equipment of all the horses of artillery and cavalry seems quite plain, little of show for polishing, &c. The guns have six horses, with similar arrangements to those of other corps for carrying the gunners: a pole is used, not shafts, long traces between the leaders; occasionally this space between the pairs of horses enables a leading pair having passed a swampy ditch, or obstacle, to get a firm footing to help the others in their difficulty.

September 14, 1869.—To the station for Heiligenbeil, a large village about 25 miles from Königsberg, where we found our horses ready for us. The principal portion of this the 1st Corps was drawn up on a plain south-east of Heiligenbeil; it had before it one of the small undulating water courses or valleys: a supposed enemy, marked by a few men, was beyond a similar but steeper-sided valley at some distance from, but parallel to, the other valley. On the order being given to advance, it was good to see from the enemy's side the whole spread out, first cavalry, then infantry columns appearing on the edge, and then crossing the first dip. On the plateau between two valleys the skirmishers met the enemy's outposts, which were of course driven in, though some farms and enclosures were supposed (by several attacks and retreats) to be contested properly. The attack on one part of this plain was made by 28 or 30 guns in battery to prepare the way for passing the main valley held by the enemy, and this was the bone of contention. Two small bridges were thrown over the broad ditch (for it was nothing more) which formed the water course. It was not actually impassable without bridges, but the cutting down the banks, &c., would have delayed troops, therefore only the baulks of the trestle bridges were laid across and floored. One of these giving passage to artillery and cavalry was laid in 3½ minutes; but no trestles were used as trestles, the baulks were merely laid across, planked and secured. The infantry passed in close sections of fours at the double, carrying their firelocks with bayonets fixed at a sort of sloped advance: fortunately no man stumbled or fell, for surely many bayonet wounds would then have occurred. The batteries, heavy and light, came down a short but very steep pitch to the bridge, the poles went high into the air, the collars of the wheelers anywhere, a man held back the wheeler by the bridle, they got down without difficulty, and did not even use a drag rope. I saw two or three batteries pass in a similar manner. When the troops had formed for attack on the other side of the gully, I saw a very good advance of three battalions (one regiment) in line, preceded by skirmishers, charging to attack with drums beating and men cheering. But it was ordered they were not to be successful here, the enemy advancing his thin line and forcing them back. But then this capital line formed column for the purpose of retiring, and under fire; and not long after, I saw a depth of several battalions remaining exposed in masses to the fire of the enemy's guns: this was, however, remarked upon as wrong, but there certainly seems a practice in manœuvres in peace of moving columns under fire. The troops marched as usual very well and steadily, and although there was no difference in principle as to the movements, yet it showed another complete corps of 20,000 men in readiness for service.

Thursday, *September* 16, 1869.—There was much conversation yesterday in the train between several Officers as to the different systems of fighting in line and in column. I was told that it was left somewhat optional with Officers commanding regiments (of three battalions): but the formation or movement of line seems but little used, except for skirmishers; the handiness and facility of commanding troops in column is tempting enough in peace to make its danger of formation under fire be forgotten.

A day having intervened since the last manœuvre, the corps was now divided into two opposing forces, which, as East and West Divisions, were to be opposed to each other near Braunsberg, a town on the River Passarge, which runs from south to north with a very winding course to the Frisches Haff and the Baltic. The county east of it has large woods, open and unfenced agricultural plâteaux, somewhat steeper water-courses, the soil deeper and stiffer than we had seen on former days, and the rain had made it on parts very heavy to move across.

The main force of a defending West Army was in position near the village of Schillwegen, with its strong outposts about one mile and a half in advance at other villages. An East Army was to advance from its position near Grünau, about two and a half or three miles from these outposts, drive them in, and force the enemy back towards the River Passarge. These general dispositions being laid down, separate orders were given to their own divisions by the two Generals, who named places of possible retreat, &c. About six miles of country in a direct line must have been passed over to-day by the East or attacking force. Early in the day, after the general advance, there was a cavalry engagement. The horse artillery and dragoons of the attack advanced through some deep meadow land, concealed by rising ground on their left, in order to get round the enemy's position; but the enemy from the rising ground brought down some lancer regiments and charged straight on their flank. They were caught; they formed up quickly, but not in time. All was well done, and with quickness of working. During the day I saw horse artillery come down one of the steep valleys and up the other side, a very sharp pitch, partly deep plough, partly irregular little grass gully, which twisted the gun and limber about seriously. This work was done very actively, the horses well whipped up on their flanks, not shoulders, one gun nearly stopped by the depth of soil and steep pitch; but all got up and went on actively through the wet plough that took my horse above his fetlock at every step. There had been much rain during the night and through the morning; the ground was very heavy for horses, even at a walk, through plough and clover; the wheels and carriages of the artillery were covered with sticky mud, yet no troops could move more cheerily over it during a long and trying day. There was no difference from other days in the system of skirmishing and attack. Positions for bivouac were taken up for the night on both sides; they were well and regularly arranged. Some of the men did not get their food till quite dusk: ½ lb. of meat, rice, potatoes, and 1½ lbs. of bread is the ration. Quantities of straw and firewood were given, and the troops would have wanted it, for it rained hard at dark, and we had to return to the station at a foot's pace.

September 17, 1869.—Elbing. By train to the village of Bömerhofen, the same district as yesterday, but more to the south, and still on the right bank of the Passarge river. The West Division, driven towards the river yesterday, was to try by a counter attack to hold some strong ground at Klopeben Windmill, whilst the East Division was to continue its attempt to force the enemy over the river. A wood in the centre between the two divisions gave excellent practice for the advances and retreats on both sides. The fighting from the supposed circumstances of the day was closer, and for that reason showed much unreality, though much activity. Artillery certainly remained exposed at 500 or 600 yards to a constant fire of skirmishers; every horse must have been killed, and certainly the close columns of battalions, and even of regiments (three battalions each) were constantly within artillery fire. But again this day's manœuvre was a very good scene and practice for marching and arrangements across unknown country. A trestle bridge was thrown over the Passarge about two miles off; we found that it had been made by pioneer companies (engineers) over night. The stream was shallow, but swift, and was crossed by about 90 feet of bridge. I was told that it was thrown last night in the dark in half an hour, exclusive of the levelling of the banks. We saw a heavily laden country waggon pass over. Chains from the head of each trestle support a main baulk of timber; through each end of this strong baulk the upright trestle passes in a mortice, and a flat shoe prevents the heel sinking into the ground. Sets of trestles are joined by beams, on which the planks are laid, and another beam passes over the plank ends, which are fixed by the rope known as a Spanish windlass. It must be a strong, expeditiously-made bridge, but is said to require a boat. We rode back to see the advance and retreat of the troops. Much was done in close columns of advance and masses of column in retreat, but artillery not much brought up on either side. Where the road led through the wood to the bridge the defence was heavy enough to prevent further operations, and the troops took up their bivouac.

September 18, 1869.—From Elbing to Münchausen and to Fürstenau in a long string of carriages, partly by country roads of holes and mud. The names of companies and number of men quartered were written up on the houses of villages; the country full of flax, which is twisted round short poles stuck in the ground, looking like large individual skirmishers in the fields. A country of very stiff clay and heavy ridges of plough, trying for horse and man. To-day the West Army had been supposed to be forced across the River Passarge to its left bank: the East Army was to advance to the river, cross it, and attack the West Army, which was to hold the line of the river. The East (attacking) Army crossed the river at the Plasswitz Mill and at the Ford of Rawusen, and the great fight was in a bend of the river at the village of Borchersdorf, the ground near which was a plateau with undulations of small relief, but sufficient to give command, particularly for artillery. From one of the projecting spurs in front of the village we looked over the lower ground and upon the infantry of the attack, assembled in columns within excellent range of artillery, which might have pounded them effectually for a quarter of an hour at about 1,000 yards distant. But the artillery was not much brought to the front. From the situation of the village in the bend of the river, the repeated attacks upon it and defence of it were closer and more concentrated than on other days. There were several cavalry movements and charges of great interest, all done with activity and apparent handiness of management, accompanied, however, by many impossibilities had it been war—infantry firing at each other standing still within 100 yards, and again movements in column under close fire of infantry and artillery. Several field batteries took up excellent positions for firing on the cavalry masses, and I saw a battalion in line firing well in three-deep formation, one rank kneeling, a very powerful means of infantry fire. The steady marching of the men was admirable over deep, dirty, and rough plough; they were always in hand, heard and well obeyed their Officers, and indeed are capital marchers,—scarcely any were falling out in these long days, beginning at early morning and from a night bivouac. They march in boots over their trousers, are covered with mud, but do not look tired, though carrying their packs, great coats, haversack, with bread, water bottle, &c. After yesterday's bivouac in mud and rain, the men and horses and guns were turned out comparatively clean this morning, evidently making the best of an uncomfortable night's lodging in the fields. This being the close of the manœuvres for the year, kind words were said by His Majesty the King of Prussia to many foreign Officers, and some were thus enabled to thank His Majesty in the name of their brother Officers for the gracious and kind hospitality given to them during a period of three weeks.

Remarks have been made in these notes on the formation and movement of columns when supposed to be under fire; these observations are not made in any mere spirit of criticism or objection. The subject was one of discussion between English Officers amongst themselves, as well as with foreign Officers, in amicable and open conversation. Different nations have different systems, suited probably to their different organization and to their national character. The subject is important equally to those liable to command as to be commanded. It is in the recollection of the authority and practice of great English Commanders in successful battle, that the system has been referred to which is a contrast to our traditional mode of fighting.

Manœuvres at Home.

Notes made in October, 1871, *on the Home Manœuvres of September, near Aldershot.*

Control.—With regard to the Control Department, an Army is no real Army unless it can move; it cannot move without its supplies of ammunition, food, and stores being near at hand, moved and controlled by the General Officers in command. The title of this department seems an anomaly. Control—what does the term mean? Control of what, or of whom? of the supplies and transport, or of the General or other Officers? The name might well be restored—for it would be better understood—of Commissariat, with enlarged duties; for it was a well-known corps identified with the Army, its movement, and supplies; or named "Army Service Corps," which would also be an appropriate general term for the duties it has to perform.

The contrast between the number—about 1,000 horses—provided in the Army Estimates for the Military Train of the whole Army, and the large additional number by which these were supplemented for a few days' manœuvres carried on from the Aldershot centre, is very instructive. The extra purchase of 800 horses, the services of spare artillery horses and men and of cavalry horses and men, besides civil transport hired in large numbers, all show the present inadequacy of this essential portion of a military establishment. And this large addition was merely to feed, and to move from and round a limited central point, only about 30,000 men and 2,000 horses.

The permanent establishment is not enough to form an efficient nucleus; it could scarcely move a division of 6,000 rank and file, including two batteries of artillery, a march of fifty miles away from its base with three days' provisions and stores.

The organization of such a corps is both difficult and expensive, but necessary. At present it has too much the idea of a cavalry corps, and would be better for more simple duties, dress and equipment appropriate to their main purpose, which is not fighting or manœuvring or drilling, but the attentive care of their horses and safe movement of stores. Debarred by their position from the motives, and possibly the distinctions and rewards of other soldiers, well-selected men should be secured, as in foreign Armies, by superior pay, so that stores valuable to an Army and its detachments should with confidence be entrusted to even a single driver detached from his corps.

It would be advantageous to the Army if those answerable for the efficiency of this corps were to see the transport even of a division assembling for its march at daylight from a peaceable camp; it is then seen how necessary is its previous organization and discipline.

The bell tent should be of linen canvas, the white cotton lets heavy rain through in a fine mist; but the new *pattern* of the cotton tent, with its shorter pole and considerably higher wall, is superior. It would tend to preserve the tents, and be a relief, if they were of a light tan colour.

The meat ration was during the manœuvres the usual three-quarters of a pound, including bone; the work in these marches and movements, with the time the men are under arms, fully justifies, I might say necessitates, a ration of one pound; the "soup and bouilli" in tin cases is objectionable, from the absence of sufficient solid food.

The steam ovens for bread baking would scarcely be practicable on service, except upon good roads, and in tolerably fixed stations in rear of an army: in these late camps carts or waggons of coke were attendant upon them. The sheet-iron field oven covered with earth is more practical, though its good baking is uncertain in wet ground.

Cavalry.—There was evident power, and good stamp for their purpose, in the horses of the Army. There will be competent opinions given as to the cavalry, the details of picketing, and other arrangements, as well as the general employment of this arm, during these manœuvres.

I do not understand why light cavalry should be in blue and heavy cavalry in red, nor why any cavalry should wear trousers over boots instead of boots over trousers, nor why they should ever wear a fixed spur, which is inconvenient and dangerous to man and horse in case of accident, and which no one uses in real riding. One regiment need not be exactly like another; on the contrary, it is advantageous to know them at some distance; but the colour of the uniform should be distinct. Light cavalry is not unfitted for its purpose by a red coat; and the darker the colour, whether of infantry or cavalry, the more distinctly is it seen at break of day, in evening light, and on the sky line.

Artillery.—It is a pleasure to see that in almost every detail of artillery for the field there is a service-like simplicity, and the absence of mere ornament on guns, carriages, and harness, which shows all being made for strength and utility. A service so efficient can, without offence, bear criticism.

It would seem that for laying a gun with accuracy, as well as firing a rifle, a shade for the eyes is necessary; yet we see an ornamental head-dress without any cover for the eyes; foreign nations apparently take a more common-sense view of this subject.

It is not service-like for artillery to carry tents upon their ammunition waggons; these are intended to carry near to their guns shot, shell, and powder, not baggage. Tents are baggage, and look like it; each first line waggon has now an extra load of nearly 2 cwt. of positive baggage, which should be replaced by ammunition, if such extra weight can be carried. Tents should be in charge of the Transport Corps; nor is it necessary, as was seen on war service in 1854, for the subaltern of artillery to have a tent when the General of Division slept in the open.

A field battery must be moveable, with fair rapidity, and with ease to those who are to work its guns. It is absurd for a field battery (as I have frequently seen, and lately accompanied) to gallop, with its guns and limbers, for more than a mile to defend a position, and arrive with two gunners to each gun. Three gunners on the limber, two more (and surely it is not necessary for all the detachment to be large men) on the gun axle seats; this has been shown in war to be perfectly practicable, and must be adopted if artillery is to "hold its own."

Reserve artillery, for a General to use on special occasions, should be horse artillery; its use need not be confined to accompanying cavalry when rapidity for other purposes may be essential.

There seems a disposition to enjoin upon artillery to take an independent part under its own officers: the late General Memorandum of September 17th does not entirely admit this view, and it is to be hoped that the discretion proposed to be given to artillery, and the subordination of its movements, will be observed; otherwise the Captain of a battery and the General Officer had better change places.

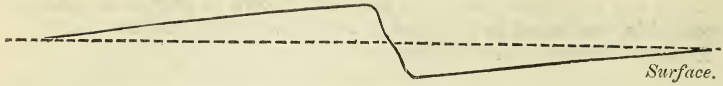
The firing of shell, and even of shot, at an enemy over the heads of infantry, unless the guns have considerable command, is convenient for artillery, but a questionable practice as concerns the infantry fired over. Sound of shot overhead is apt to distract in action, whether from enemy or friend; and one shell from a friend in rear bursting short may almost disorganise a battalion in its advance under fire. Possibly shell, at high elevation with low charges and great range, if practicable from field artillery, would be safe over our own advance, and very damaging to an enemy. There are few things more difficult to avoid, or more dangerously disagreeable to troops, than the sound and arrival among them of mortar shell.

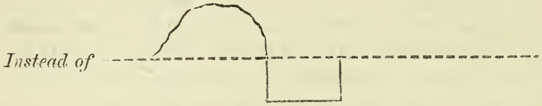
Engineer.—The engineer trains for telegraphing, for pontooning, and for the carriage of working tools for themselves, and those on pack horses for the general service of infantry, seem well arranged for their purpose, and are essential to an army. There are subdivisions or sections which can be detached with all sorts of implements for strengthening outposts, or passing obstacles, and the pack horse arrangement is good for infantry purposes.

I do not know whether late wars on the Continent have shown the power of the telegraph for orders in the immediate presence of the enemy. This may be doubted; but there is no doubt of its practical utility and ease of placing on main lines of operation. The French wire cylinders are made narrow, to be placed on a pack animal, and the wire laid down from it if necessary.

In the Hanoverian manœuvres of 1857 I saw a trestle bridge which accompanied the troops, and which was thrown quickly during the manœuvre over a deep but narrow canal or water course which stopped the march. Field artillery passed over it: it might be worth the attention of engineers, as simple and effective.

If the trenches made at Chobham were "shelter trenches" for a temporary purpose, they had better not be formed with perpendicular sides; an enemy getting possession, could use them at once for cover. They, as well as rifle pits, should be sloped at a very small angle, thus:—





There would be the same amount of cover on one side, but none for an enemy; and it gives much less obstruction to the movements of one's own troops of all arms when necessary.

Infantry.—If infantry is to be called upon to march and then to fight with activity and with ease, the knapsack must either be reduced in size and weight to the barest necessity, or it must be carried by transport. It is the weight that kills and makes casualties, and the marching and fighting qualities of the soldier must not be sacrificed to anything.

Rain is the great evil to the camp, the bivouac, and the march; the equipment for service in 1856 was the great coat, to be only folded into the sleeve without any pins or fastening; under its straps was to be carried a thin sheet of india-rubber material, 6 feet by 2 feet, with eyelet holes. This could easily be put over the shoulders on a march, and be useful for other purposes. At present the great coat is pressed into shape and fastened with so much trouble and nicety, that care is taken not to use it. It should not be of thick, heavy, or spongy material, for the soldier has to carry it dry or wet; but the small waterproof above mentioned would keep it dry on a march.

The present half boot is neither a boot nor a shoe: if a boot, it should be the laced boot, the usual wear of the peasantry of England, to fit close just above the ankle in order to keep out dirt, and be supplemented by a close fitting legging from the ankle to below the knee, thus taking the weight of the trouser off the knee in marching, a practice universally observed by those who work hard. What has become of the old light infantry knee-pad? It surely might be useful with the present rifle position of the soldier, whose trousers seem now to be made tight where they should be loose, and loose where they should be tight. He would be a benefactor to the soldier who would make his dress easy and fit for hard work, and who would invent a fairly waterproof, but soft and substantial head-dress or helmet which would fit like a hat, and which he would not be tempted to get rid of on service in order to wear his forage cap.

A soda-water bottle, hanging by its neck and dangling about, is not a good arrangement for the soldier; it is heavy in itself, and holds a very small quantity: it had better be of tin, well soldered in the inside to prevent rust, its shape rounded out to fit the side; it should have a large mouth with a cork bung, over which should fit a small cup. I have seen this in a foreign army; the strap should be broad, and go round the bottom of the bottle to bear its weight and keep it steady.

The colour of the infantry coat is bad, and discreditable; it is well termed "brick dust," and its appearance kept up this character at the final march past of the corps at Aldershot on the 22nd ult. It deserves its technical name after short wear, from showing the white cloth underneath the worn-off scarlet surface; for this cloth, made up white, is dyed in the piece, not in the wool. Far better would it be to give up such attempts for bad scarlet, and adopt a real good bright red, such as the French or Turkey red. This is dyed in the woollen yarn before it is wove into cloth; the colour remains good, being in the grain, and is far superior to an attempted scarlet, which soon shows its inferiority by wear.

With very few exceptions English fighting troops of all arms should have red coats; distinction from an enemy is of importance. There have been many instances of fatal mistakes; even lately at Sedan Bavarian infantry was seen to be shelled out of the village at Balan, by Prussian artillery firing from the opposite side of the Meuse, at about 2,000 yards distance.

There were instances of the ammunition carts and regimental colours, when in camp, being given in charge of the quarter-guard in front of the battalion towards the enemy. The quarter-guard is not for this purpose; the front of a battalion camp should be kept entirely clear or assembly. The quarter-guard is the means of communication and alarm to the battalion from its outlying picquets, and its sentries should be in communication by sight and signal for re-inforcement to the outposts, or to get the battalion quickly under arms. The colours should be at the tent of the commanding Officer; the ammunition in rear of the battalion.

In most cases the skirmishing of the troops under my observation was fairly done where the country admitted; men advancing short distances rapidly to cover, remaining there firing, and then running to other cover; in other cases there was slow exposure in advance and retreat, and a tendency to collect together; this bad habit requires correction, for the proper occupation of cover by skirmishers should become an instinct by enforced practice in peace. Every one must have rejoiced at the absence of bugling; there is no greater source of mistake and confusion than perpetual company and battalion bugling in the field. It would almost be good for the mouthpieces of bugles to be taken possession of by an Officer or a sergeant when in presence of the enemy.

It is right for the large cooking tins to be carried by transport, and not by every sixth man. They are cumbersome to carry; they are got rid of frequently, and casualties to men render many of them not forthcoming. But there should be occasional practice of halting and quick cooking in the small mess tins during a march; if the ration of meat were one pound, which it should be, half of it and of the bread should be carried and cooked occasionally in the march by the soldier; the other half to be cooked in the large tins on camping.

It is unnecessary and disadvantageous for an ambulance waggon with two horses to be as close up with a battalion as its spare ammunition. Even on Hartford Bridge flats the jolting and jerking would almost have broken the limb of a sound man, and certainly could not have been borne by a wounded man. Wounded men should be carried from the field by hospital men with stretchers, whose special duty it is, and thus, as in other armies, prevent any soldier quitting the fighting ranks. The ambulance waggon or cart to be used mainly to convey wounded to the division or other hospital.

It is to be hoped that there will be no tendency to diminish the steadiness, the solidity, and the military regard due to English infantry. It is the first arm of the service, the only one really self-dependent in action; it is the main strength of all armies; to which cavalry and artillery are but accessories, notwithstanding their power. The infantry should be the senior, the preceding service in line and in parades, as it is the most important in war. It is so placed in other armies than that of England; and the spectacle is not seen of clouds of dust raised, and of ground cut up by cavalry and artillery, for infantry to march past upon in their track.

I do not think that the steadiness of movement or real rapidity of formation of infantry has of late years been maintained. I was in command of a battalion at Chobham Camp, in 1853. Lord Seaton counselled and ordered the loosening of *files* for ease of movement on such ground, but he did not order or counsel looseness of manœuvre or formation.

I speak of the steady movement of infantry, and particularly of English infantry as a quality to be valued, and it has been valued by our enemies as well as allies; quickness and "doubling up" in manœuvres may be pretty theories, good sometimes for parade show, or perhaps occasionally necessary; but it is the duty of Officers to husband the strength and wind of the soldier, who carries 60 rounds of ball cartridge, his knapsack, his water bottle, and his haversack of provisions on service.

Some late alterations in drill, and even words of command, have not added to the steadiness or compactness of infantry for the purposes of war. For instance, the increased distance of 30 paces ordered between battalions; the formation of line, the special fighting formation of English infantry, is for the purpose of advancing to close attack, or to give close fire; but I have seen with well drilled battalions in Hyde Park those 30 paces become 70; and I have seen in the late preliminary manœuvres those 30 paces extend to 100 between battalions; necessitating the unsteadying of a line and great loss of time, in moving battalions in brigade by fours to their right or left. If the reason of this increased space, and consequent weakness, is to admit the passage of other arms, is it not still practicable to wheel companies? The front of brigades and battalions is more likely to be diminished on service than increased; a skirmishing company ordered from a battalion, a skirmishing battalion from a brigade or division, makes a gap, and killed and wounded make gaps; there is no necessity for increasing unavoidable spaces, which diminish the power of fire, which may enable the enemy to take advantage of a weak point, and to mark the strength of opposing battalions to a nicety.

The more frequent orders than formerly to change the dressing or directing pivot of a battalion, is another source of unsteady movement, producing a shifting and swaying of the men, and an uncertainty of direction, frequently at the wrong moment.

A good, distinct, and easily understood word of command was lost to the Army when the "Right or left shoulders forward," with its clear sound and caution, was replaced by the word "wheel," with scarcely any caution; nor is the word "half battalion, half company," an advantage over "wing" and "subdivision." I have more than once seen a whole battalion mistake the word of command to itself of "half battalion" being given to a wing for another purpose.

The small arm ammunition carts for each battalion, drawn by two horses, kept up fairly, but they had only blank cartridge. I did not observe any cradle or pack saddle for putting boxes on horses to supply places not accessible to wheels. There is in writing the strongest opinion by the late Lord Hardinge that the first reserve of infantry ammunition should be on pack animals, so as to be with a battalion in any position, and not impede the line of march by wheeled carriage. There was an arrangement for a Maltese cart with mules, and spare mules, in 1856, which might be worth attention.

It may be advantageous to be able to use a portion of a battalion for a special purpose without diminishing its fighting front. One foreign army forms its infantry in three ranks for this purpose, taking the third rank for its skirmishing attack. A battalion of ten companies might have the following formation:—Two companies as active marksmen, to be one in rear of each outer company of the battalion, the flanks of which would thus be strengthened for defence or for sudden advance, or for the occupation of points of importance, without diminishing the front of the line and its efficient fire; these two companies might add their fire over that of the ranks in front of them when kneeling.

The long rifle with a short and light bayonet should not be given up for the general infantry: it ensures safety to the front rank when firing in two ranks, which the short rifle does not. The weapon, whether rifle or bayonet, had better be kept intact for its main purpose—fighting: its efficiency should not be risked by its use as a saw or a chopper. Axes and bill-hooks are now carried in a cart close up to a battalion: every soldier should have his own clasp knife, and have no excuse for any other use of his rifle and bayonet than for its proper purpose.

I will not omit referring to the recommendation and practice that squares should be formed two deep. Any one placing himself at 1,500 or 2,000 yards from the battalion in square, will see how much more extensive a target for artillery is the two deep than the four-deep square: it is double the extent of front; it takes twice the time to form; is weaker when formed, and gives no additional fire. If the accounts of cavalry Officers in war are reliable, it seems that the tendency of cavalry under fire of a square, is to open out and pass the square: this tendency is helped by the concentrated fire of a smaller rather than a larger square. Cavalry will scarcely charge direct upon a front of infantry in position; but fog, concealment by ground, or smoke in battle, may give the opportunity of sudden or flank attack, when the rapid and substantial formation of square should be instinctive in every company of a battalion: in the midst of noise, smoke, and fighting there must be no uncertainty as to what sort of square is to be formed. Our English 4-deep square has long stood the practical test of war; its steady formation and resistance has been proverbial, and should scarcely be subjected to experiment.

In the narrower or parish roads the whole space was frequently occupied by the troops on their march, preventing easy and necessary communication of orders; the front of infantry in fours, with an Officer or Non-commissioned Officer besides, is too great except on turnpike roads. This communication of orders is of importance: the passage of mounted Officers and orderlies should be along the pivot flank, the reverse flank being close on the outer edge of the road. This should be an essential observance in route marching at all times, and staff and other mounted Officers should be cautious never to alter this regimental formation when passing with orders.

It might be advantageous for the General Officer commanding, and the staff and departments of each division, to have a distinctive pennon, colour, or badge. The mounted orderly of a French General carries his particular pennon, which is seen and known, and a coloured badge fixed temporarily on the arm might be suitable for others.

I do not refer to the main strategical movements of the troops. The general outline must, almost necessarily in England, be settled beforehand, rather reversing the practice of war; and unless the transport service is complete, disciplined, and under the orders of the General Officer, "strategy" must be subservient to a previously arranged delivery of food and fuel.

It is my impression that the daily movements extended over too great a space. The flank marches and proceedings distant from the sight of the enemy may have been practice for the two or three superior General Officers and their staff; but if the movements are to be of utility and military interest to Commanding Officers of battalions, to the Officers of their corps, and to the soldier generally, they should be more concentrated,—rather tactical than strategical,—so as to give Commanding Officers of battalions, their Officers and men a better insight into their duties of attack and defence on ground where a Brigade-General can have his troops under his own eye, and where the troops themselves can see how they support each other in attack, in defence, or retreat. To take the experience of one of the brigades composed of seven battalions—too large a number for a brigade-command—during some of the four days of supposed war movements: the principal occupation of most of these battalions was to march for hours between two hedges along a dusty road, sometimes beginning their contact with the enemy by each firing at the other along an open road from not being allowed to occupy enclosed land on each side. On one of these days a whole division of thirteen battalions only came in sight and contact of the enemy, after a march mainly along enclosed roads of about seven miles; the position of the Hog's Back on the east, to

Beacon Hill on the west, was an extent of about eight miles, and the troops in supposed occupation of it (exclusive of cavalry and artillery) amounted to less than 7,000 rank and file, including a skeleton force derived from Aldershot for the morning. I only refer to this extension of the troops to show that greater concentration of defence and attack would give more practical interest to those employed. Nor can it be forgotten that such extended lines have an element of weakness, and are scarcely consonant with war practice.

The advance of 50,000 men to attack the position of the Alma covered scarcely three miles frontage of the ground; and the movements for the battle of Vionville and Gravelotte, with 230,000 men on one side and 170,000 on the other, extending even to the bridge of Pont à Mousson on the Moselle to the south, did not extend over a greater space than fifteen English miles from Metz, and less than that distance to the west of it.

I submit that professional advantage would accrue to the body of the troops employed, by their movements being confined to a smaller daily area than in the late movements near Aldershot.

Referring to matters of mere parade, when troops are in line or line of columns, the fewer mounted Officers there are in front the better the troops are seen. In marching past, the General Officer should be the leader in his own person of his Division or brigade, closely followed by his Staff in one line; and as these latter Officers do not draw their swords, they had better not salute at all, than do so with their right elbows towards the saluting point on their right.

In all the camping and simulation of war service there should be no omission of the traditional practice and precaution of the English Army, for all troops to get under arms an hour before daylight every morning when in presence of the enemy. This should be a habit even in peace manœuvres—the men to remain in their tents with their arms if the weather is bad, until safe information comes from the front.

In bringing these remarks to a close, let us remember that all peace manœuvres are but to secure a readiness for war; and that amidst the theories, the maps, and speculations, fighting, hard fighting, will remain one great element of success.

Terms of depreciation are now used of "English lines standing up "to be shot at," of the "antiquated way of fighting in line:" but history and the practice of our great Commander shame these expressions, and show that the English formation of line has always overcome the more antiquated formation of column.

Troops in line give most fire, have most individual power, and suffer least exposure either in attack or defence. The range and accuracy of artillery ought to overwhelm troops in column; and the experience of some attacks in the late war in France confirmed to those engaged, as it might well confirm to us, the danger of such formation under fire. Attacks by skirmishers are surely no new invention, but they never succeeded, by themselves, in taking a position solidly defended.

Of those hereafter in command, from the subaltern to the General, there will be required anxious thought and perhaps sudden decision, on the best means of bringing men, either in attack or defence, to the decisive closing point with the least loss of life; and attention may well be given to the suggestions or practice resulting from experience, and adopted whilst fighting was going on during the war of 1870.

I refer to the dispersion of troops in open order to commence fighting, and to their subsequent concentration *in advance* for that closer order of attack by which alone success is secured.

To overcome difficulties, to require bravery, exposure, and self-denial, mutual confidence between Officers and men is essential; similar confidence between man and man of the same company, and the same battalion, is equally essential, and we of the English Army have long felt pride in this security. It is not the growth of a day: it depends on time, habit, and tradition, as well as command; it forms the best part of our regimental system, by engaging each individual in the well-being and honour of his corps.

That nothing may break that confidence between man and man, or mar the gentlemanlike—as well as the military—confidence between Officer and Officer, that the existence of a battalion with its tradition and *esprit de corps*—the result of slow but strong growth—may not take the form of a passing and disjointed assembly of recruits, must be the hope of all who know the Army and have at heart its permanent welfare.

The CHAIRMAN: As Vice-Chairman of the Council I have to thank you, Sir William, for the paper you have read. I fully expected when you did us the honour to consent to give a lecture here, that from the opportunities you have had of making observations both at home and abroad, it would be of a practical character. I may say that that expectation has been fully realised. The lecture, moreover, is calculated to give rise to much thought, and to the consideration of the many useful and practical points of detail which it contains.

Evening Meeting.

Monday, June 24th, 1872.

General J. R. CRAUFURD, in the Chair.

NAMES of MEMBERS who joined the Institution between the 18th and 24th June.

LIFE.

Pratt, S. C., Lieut. Royal Artillery.

Clerk, Godfrey, Lt.-Col. Rifle Brigade.

ANNUAL.

Cologan, J. Fitzgerald F., Captain 18th Bengal Native Infantry.

Bland, T. E., Lt. 5th West York Mil.

Gibbs, John, Lt. 5th West York Mil.

Bunbury, Charles T., Capt. Rifle Brig.

Acland, C. T. Dyke, Lieut. 1st Devon Rifle Volunteers.

ON THE LATEST CHANGES MADE BY THE PRUSSIANS IN THEIR INFANTRY DRILL-BOOK.

By Major E. M. Jones, 20th Regiment.

The Chairman: Major Jones, who is about to read us a paper on "The Latest Changes in the Prussian Infantry Drill-Book," is particularly qualified to undertake that task, having formerly served for three years in the Prussian Guard. Before he begins his lecture I will—just as an introduction—read a translation of a short preface to the new edition of the Prussian Infantry Drill. It runs thus:—"I hereby approve of the following reprint of the Regu-" lations for Infantry Drill, which contains the alterations directed by " me, and I order that what is appointed by it shall alone henceforth " have authority. At the same time, I repeat that which was declared " as his pleasure by my brother resting in God, King William Frederick " the Fourth, under the date of February 25th, 1847, to this effect— " that the discretion left by the regulationary directions for the forma-" tion and application of the troops, shall not be contracted without a " stringent cause, as what is merely formal might thereby take pre-" cedence of what is essential." I thought this preface so characteristic of the whole spirit of the new Prussian infantry drill, that it was desirable to read it before calling on the lecturer to proceed with his paper.

Major Jones: The first thing that strikes one on taking up the new edition of the Prussian Infantry Drill-Book is, how little it seems to differ from the old one. The alterations are contained within the compass of a moderate sized pocket-book in Colonel Newdigate's translation, and only cover some thirty pages in Lieutenant von Biberstein's pamphlet "Was Enthält das neue Reglement." The general arrangement is the same; the headings of chapters and sections are scarcely altered; a few forms have been dropped; some improvements introduced; the "general "remarks" rewritten and enlarged; and that is about all. There is no startling or sensational change, such as might perhaps have been expected considering all that has happened in the military world since 1847, the date of the last edition, and the numerous works on Tactics which we owe to Germany. Those works give abundant evidence of the energetic and progressive spirit which animates the Prussian Army, and which led Baron Stoffel to use such expressions in regard to it as "Avide de progrès;" "on dirait d'une ruche d'abeilles," &c. Opinions are free, and thought is encouraged; any one who has a suggestion to offer, or a reform to propose, is sure to find an attentive audience, an unprejudiced tribunal, and, if his work will bear proof, proportionate acknowledgment. But it must stand the proof, and the same rigorous practical test is applied to all. For instance, the "Vortreffen," or advanced line was referred to twelve years ago by Prince Frederic Charles, in his well known brochure "How to Fight the French," as a tactical formation which had been recommended to him on the highest authority, and tested on the drill-ground with success. Yet it s only now officially adopted in the new drill-book, after having been extensively employed in the late war. The higher ranks in the Prussian Army may seem sometimes to be simply conservative; even here, in England, we have heard it hinted that the talented author of the "Taktische Rückblicke," was not appreciated in his own service as he deserved. It may be doubted if we in this country are altogether qualified, even if we are called upon, to pronounce an opinion on the subject. My own impression is, that in the higher circles as elsewhere in Prussia there is a keen desire for progress; only it must be *well considered* progress. Over-eagerness and indolence are alike discouraged, and the standard aimed at is a happy blending of great mental activity with studied calmness of judgment. It would not be easy to illustrate the way in which the path of reform is followed up in Prussia better than Baron Stoffel has done in his report of 22 July, 1868 (p. 191):

"Depuis deux ans, il s'est fait ici, sous le seul rapport des perfec-"tionnements à apporter dans les différents services, un travail con-"sidérable, travail opéré sans bruit, sans ostentation, mais avec beau-"coup de réflexion et d'esprit de suite. Au ministère de la guerre, "aux états-majors des corps d'armée, dans les diverses armes ou ad-"ministrations, fonctionnent des commissions composées d'officiers "ayant fait la guerre, qui étudient toutes choses, en vue de profiter de "l'expérience acquise en 1866."

The new edition of the drill-book resulted from the labours of one of these commissions and, in the first instance, exclusively from the experiences gained in 1864 and 1866. It was just ready for promulgation when the war with France broke out, the Royal Order by which it is prefaced being dated 3rd August, 1870. It was not, however, promulgated for another year. There would be obvious objections to the introduction of changes in drill during the progress of a serious war, objections which would perhaps be more strongly felt in Prussia than elsewhere. The new regulations were accordingly kept back until some months after the conclusion of peace, and then given to the Army almost, if not absolutely, without modification.

It may be assumed, then, that the new edition embodies all the changes which were necessary in order to bring the system of drill into harmony with the spirit and tendency of the *latest* Prussian tactics; if further changes be in contemplation, they cannot be vital, and are probably such as leave room for difference of opinion. We may be assured, moreover, that they have not been evolved, like the celebrated camel, out of the inner consciousness of a military philosopher, but have grown out of the practical experience of recent wars, and been matured by the keen thought and patient judgment of tried soldiers. All this makes it more than ever matter of regret that the treatment of the subject here did not fall into the abler hands to which it properly belongs, and for which it was originally destined, but I may perhaps hope that the imperfect remarks which follow may lead to a fruitful discussion by Officers of wider experience and greater authority than myself.

And first, to allude to the movements which have disappeared altogether from the drill-book as obsolete or superfluous. The principal of these are the "Achs-Schwenkung," or change of front of a battalion on its centre; and the "Aufmarsch der geöffneten Colonne," or formations of line from column at wheeling distance. The former was only retained in the old regulations as an "exercise for the drill-ground intended to make men and officers handy," and is now omitted altogether. On the other hand, the old form of deployment on a rear-division (Zug) "aus der Tiefe," is retained, though with an accompanying caution that the inversion of the divisions in a battalion should not make any difference.

The tendency would appear to be, while rejecting all such movements as would certainly be out of place before an enemy, to keep those which might by possibility be of occasional use. It is not, I believe, that the Prussians have grown indifferent to the value of mere drill movements, of evolutions which answer no purpose, and are intended to answer no purpose but that of making Officers and men handy; on the contrary, the proverbial strictness of their drill is as great as ever, and many of those present have doubtless noticed within the last year that the old exact attention to minute detail is still required from Officers and men. This strictness is indeed a symptom only, but it is a very suggestive one, and indicates the great importance which is attached to the careful, thorough training of the soldier. But it would seem to be felt that training must be carried a step further than it used to be. It is no longer enough that Officers and men shall be competent to execute with perfect precision movements rigidly defined by regulation; the Officers must now be prepared to direct movements for which words of command are not prescribed, and the men to carry them out without previous practice. So, for instance, section 53, chapter X, refers, as in the old edition, to change of front in line without inversion, and indicates the methods by which it may be effected, but without laying down any precise form or word of command.

Another class of alterations includes those which represent the modification or fuller development of a tactical principle. Such are, for instance, the changes in the rifle exercises which are not due simply to the adoption of the needle-gun. Among these are the more definite and practical instructions laid down for aiming and firing; the substitution of "quick" for "file" fire; the increased distances at which firing is allowed, and the introduction of volleys in four ranks, the two front ranks kneeling. They all tend in the same direction, and aim at increasing the effect of infantry fire. Not that this is by any means a new feature in Prussian tactics. It dates at least from Frederic the Great. But now as before, and now more than ever, the object of their drill regulations has been to train the men to cool, accurate, and concentrated fire at effective range.*

Under the same head may be classed a modification which has been made in chapter II, section 16; according to which divisions (Züge) of *sixteen* files and upwards, not *twenty* as previously, are to be told off in half divisions. The object is to get greater flexibility, and columns of smaller front, which can be more easily placed under cover.

The last change to which I shall allude under this head is contained in Part III, chapter X, section 55 (56 of the old edition), and directs the formation of the skirmishing divisions each in rear of its own company, instead of taking post, as formerly, behind the flanks of the battalion. It is probably the most important in the book, representing as it does the victory of a principle which has been growing and gaining strength in the Prussian Army, more especially since 1866, and which meets us at every turn in the best tactical works, I mean that of keeping their tactical units down to the very smallest, as far as possible, unbroken and unmixed.† It aims at referring the men of each company and of each section even, always in the first instance to their own section and company for support, each company to its own battalion, each battalion to its own regiment, and so on.

Under the old system, the formation of the skirmishing divisions was the signal for a partial disorganisation of the battalion. The picked men, who formed the third rank, were taken away from their companies, and the command of the skirmishers of the whole battalion was made over to one of the four Captains selected for the purpose. His company was thus deprived of its leader just when the moment for action arrived, and he was placed in charge of a number of men dispersed as skirmishers, most of whom in all probability belonged to other companies. *Now*, each company will remain together under the command of its own Captain and the guidance of its own Officers, and each will, as a rule, support its own skirmishers, and will act, under all circumstances, as one organic whole.

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* Compare "Verordnungen über die Ausbildung der Truppen für den Felddienst und über die grösseren Truppenübungen," p. 109.

† See page 160, where the principle is laid down in so many words.

An incidental advantage of the change appears in the formation of company columns from the column of attack (or double column as it used to be called) and *vice versâ*. Under the old system, when the skirmishing divisions were formed in front or rear, or partly in front and partly in rear, of the double column, a certain amount of time and movement was entailed in forming company columns. This is avoided now; the column of attack, with skirmishing divisions formed, being to all intents and purposes nothing more than the four company columns massed on a front of two divisions and brought under the immediate direction of the battalion commander.

The gain in point of simplicity and directness of control is obvious; nor is it attained by any sacrifice of real efficiency. The old distinction between the third rank and the others, according to which the men in the former were destined exclusively for skirmishing and the latter for fighting in close formation, has been abolished, and all ranks alike are now to be employed in either way, though the third rank will still be composed of men especially selected for the duty of skirmishing.

Another minor result of the change is that a slight increase of interior space in square is obtained. The preference for the solid square still appears to exist, though we may perhaps see the thin end of the wedge introduced in the new method of forming company square (chapter IX, section 42) by which one, the third, half-division wheels outwards to form the sides of the square. It is true that the well-founded objection to the use of the solid square which lies in its limited front of fire has lost some of its force in these days of breech-loaders.

The change which we have been considering, and the larger and more effective application of company columns, which is intimately connected with it, may throw some light on the retention of three ranks in the Prussian regiments. It may have seemed probable to many of us, that the formation would be abolished and that all the infantry would in future be formed in two ranks as is the case elsewhere and even in their own rifle battalions. There were in fact, I believe, many advocates for the change, and it seems, *primâ facie*, a needless complication to have one formation up to the moment when fighting is to begin, and another for the action itself. But there will appear on consideration, a good deal to be said on the other side, at least from a Prussian point of view; and we may imagine the supporters of the old system to have argued something in this way: "We need say nothing about the greater solidity which is possessed by a line three deep, because we do not contemplate any extensive use of that formation in the field. Practically all or nearly all our fighting is done in company columns, and we use two ranks when it is desirable and three when they are in place. The only objection to the practice which we are concerned to meet, is that the change from 3 to 2 ranks, on assuming formation for action (Gefechtsformation) is mischievous. The arguments against it appear to us more specious than sound, and to spring from a wish for theoretical uniformity rather than from any proved inconvenience. It can hardly be seriously maintained that the manœuvre implies or actually produces confusion or appreciable loss of time. If it be contended that the practice is not absolutely mischievous, but only unnecessary, we reply that it gives us two or three distinct advantages which we are not anxious to part with. In the first place, it shortens the line and therefore the depth of the column on the march. It also enables us to keep our best skirmishers distinct from, but close in rear of, the other two ranks, and gives us the power of using them in extended order, without causing confusion or diminishing the extent of front, and of placing our hands at once on the men we want, if a few well-aimed shots are to be fired at long range. We do not believe that these advantages can be obtained in any other way to the same extent and with so little drawback; and, unless some positive gain is in undoubted prospect, we consider that we had better hold fast to a system to which the Army is accustomed and under which it has so far got on pretty well."

Whatever the arguments were, they have prevailed, and for the present at least, the Prussian Infantry regiments will continue to be formed three deep until they go into action.

The largest amount of modification is to be found in the sections of "general remarks," and in the chapters of Parts IV and V, which treat of the "battalion in action," and of the "brigade." Naturally we have not to do here with definite omissions or alterations; but, as these chapters really indicate the difference which exists between the views held by Prussian tacticians 25 years ago, and in the present case I propose to offer a condensed abstract of them compared with the corresponding ones of 1847; referring those who wish to examine more closely into the matter to Colonel Newdigate's translation.

Chapter XVII, sections 100—108 of the new, corresponding to sections 108–116 of the old edition, introduces minor modifications only, the most prominent of which are as follows: in a long line of skirmishers, detachments or patroles must be held together to support or secure the flanks: skirmishers charging, are to close *in* the enemy's position under direction of their Officers: a line of skirmishers is, as a rule, to be reinforced by prolonging it; in any case, the men of the reinforcing party must be kept together, the old skirmishers reducing their intervals so as to leave a sufficient space for it: closer supervision and control of the men's fire is demanded from Officers and Non-Commissioned Officers.

In chapter XVIII, the introductory section strikes the key note of the whole, by insisting on the importance which attaches to the action of skirmishers in the present day, and on the fact that "the possibility of "concentrating their fire in respect of time and place gives them a power "of *offensive* action, which may under favourable circumstances be, by "itself, decisive." It is a rule, therefore, in regard to the application of infantry fire, that it should be concentrated on the most important point for short periods of time. The enormous strength which is thus secured in front, brings out more than formerly the importance of the flanks in attack and in defence. The ideas here indicated, are worked out more fully in the succeeding sections; more especially in those numbered 113–115, which have been entirely re-written in the spirit of the latest Prussian tactics.

Sections 120–121 of the old, like 112–113 of the new edition, speak of "fighting in extended order and its combination with close formations." The former lay down, that on open ground the attack and defence, though introduced and covered by skirmishers, must be put through by the battalion, as a rule in column, and that it is only in an intricate country, where troops cannot move in close formation, that the latter must be looked upon merely as reserves, and the actual contest carried through by the skirmishers. The new regulations, on the other hand, while they admit that a battalion may possibly have to act in close formation, point out that in most cases those engaged in first line must be broken up into smaller fractions, and that the use of company columns must be the rule when the object of the engagement is to be obtained by the *fire* of the infantry. Proceeding to consider the question more in detail, they insist in the case of an attack in front,

1. On the necessity of previously subduing the enemy's fire by pushing the skirmishers up within close and effective range;

2. On the use of sufficient force in the attack; and

3. On taking *instant* advantage of any opening which the enemy may give; for which it is essential that the officers who are actually leading the troops engaged should act on their own responsibility in judging when to charge.

In the defence, the main points are to secure cover, either natural or artificial for the men, while obliging the enemy to pass over an exposed space under effective fire; and to confine the defence to one line only; the temporary occupation of advanced points being condemned, because heavy loss is sure to be incurred in evacuating them.* The pursuit of the enemy, when his attack has been repulsed, may be conducted by fire alone, and should be, unless it is possible to gain a fresh line in advance.

The increased effect of modern fire renders the front of steady troops practically unassailable, and enforces greater attention to the flanks both in attack and defence. Hence the necessity for considerable depth of formation, in order to provide for re-inforcing and prolonging a flank in line, or in echelon to front or rear.

The above remarks apply to the case of ordinary, tolerably open ground. In a close country the action will be almost entirely carried through by skirmishers and the importance of guarding by every possible means against the danger of the men getting out of hand is dwelt upon. In this view it is essential that no intermixing of battalions, companies, &c., which can in any way be avoided shall be allowed to occur.

The company column forms the subject of the next section (114 new, 122 old regulations) and here the difference between the two editions comes out strongly, not only in that the use of company columns is far more frankly accepted in the new one, but even more in the manner in which it is sought to provide against their acknowledged dangers. The edition of 1847 explains that company columns are useful in close broken country, but are unsuitable for open ground, and little capable of repulsing cavalry; and much stress is laid upon the danger of the companies getting out of hand, and the battalion commander's control being lost. In order to guard against abuse in this direction, definite limits are laid down, within which their employment is permitted, *e.g.*, that the companies are to be brought into action gradually, one at least being always in reserve, that the interval between companies shall not exceed 80 to 100 paces, &c. The present edition starts by saying that battalion columns are too deep to be used within range of artillery, and that accordingly the general employment of company columns has become matter of simple necessity. The risk of their getting out of the control of the battalion commander does not appear to be thought less of, but is guarded against in a different way. Officers are given to understand that it is their duty to rejoin their respective commands as soon as they have accomplished any service on which they may have been detached. At the same time it is distinctly expressed that the advantages offered by the skilful handling of companies by their own officers acting with a certain independence are to be turned to the fullest account.

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* It might be added that the notion of "temporary occupation" is too closely connected with that of giving way to be a wholesome one for soldiers.

Among the advantages attaching to company columns it is pointed out that they can obtain cover more easily than united battalions, that the men are more easily rallied in them, and that they provide very conveniently for a gradual development of force. In this latter respect the "Vortreffen," or advanced line, demands especial notice. A battalion in this formation would have in front a line of skirmishers, with supports 150 paces off,* both furnished by the third rank of the two flank companies; 100 paces behind the supports, the rest of the two companies would follow, with an interval between them equal to the front of two companies in line; the two centre companies would follow as a half battalion at 150 paces distance, and usually in rear of the centre of the interval. This formation is recommended as affording considerable depth and facilities for adapting itself to any line of action that may be advisable.

The last section of the chapter consists of "general remarks" which have been greatly amplified in the new edition. In their old shape they laid stress mainly on the importance of close and constant connection and mutual support between the battalion and its skirmishers. More definite principles are laid down now. For instance, a battalion when near the enemy must always be covered by skirmishers, so as to be perfectly secure against the danger of receiving infantry fire unexpectedly; every point won must be secured, the retreating enemy being pursued in the first instance by fire, then by skirmishers properly supported; the troops should never be more broken up than is essential at the moment, and detached bodies or skirmishers always tend to rejoin; the advance to be deliberate, the retreat calm and measured. Lastly, few forms, but perfect training in them; unflagging attention to commanding officers, and thorough tactical cohesion are insisted upon as the essential points.

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* The distances are only for the drill ground.

Chapters XIX and XX of Part V are devoted to the brigade and to developing with reference to the larger body the principles of action contained in the previous chapters on the battalion. The following are some of the points in which the new regulations differ from the old. Section 122. The distance between the first and second line is to be fixed by the brigadier according to circumstances. Section 123 allows all the battalions of the brigade to be deployed in a general advance; the old regulations prescribed the double column for the second line. Section 125. In case an attack has failed, the skirmishers are directed to hold their ground till recalled, or at least as long as the enemy will let them. Section 127 recognises the convenience of the echelon for advancing or refusing a flank, and for effecting a slight change of front in brigade.

The concluding section, headed "General Remarks," is much fuller and more elaborately worked out than the old one, and its instructions are based on somewhat different principles. While the old regulations admitted—apparently not without regret—that it was impossible to prescribe precise forms which should meet all cases, and that a certain freedom of action and individual responsibility must be allowed to Commanding Officers, even on the drill ground; the new edition not only accepts the fact heartily, but recognizes in it the means of arousing the intelligent interest of Officers, and imbuing them so thoroughly with the spirit of the regulations as to ensure its being always carried out in the best way that the circumstances of the case will allow. Certain evolutions are laid down, but only as examples, and Commanding Officers are required to practise modifications of them suited to the nature of the ground, the co-operation of other arms, and the measures of an enemy supposed or represented.

The vexed question which has been so much debated by German tacticians, whether the two regiments of a brigade should be drawn up side by side or as two lines one in rear of the other ("flügelweise," or "treffenweise")—affords a good illustration of the practical character of these regulations. It is alluded to incidentally towards the end, the arrangement of the brigade throughout the preceding sections having been spoken of as in two lines, one regiment in each, or in three lines, one battalion of the regiment which forms the first being advanced, or one battalion of the other regiment, which forms the second line, being held in rear as reserve. It is pointed out that circumstances may make it desirable that the regiments should act side by side, as, for instance, where the action would turn on the possession of two more or less disconnected points of a general line, or where great depth of formation and special attention to the flanks were in place. The essential point is shown to be, that the regiments should, as far as possible, be kept distinct and unbroken, and intermixture of battalions, companies, &c., be avoided.

The observations contained in pages 198–201 are so characteristic of the spirit of the book that I think I cannot close this slight survey better than by a free rendering of their contents:—

" Officers commanding regiments and battalions must be accustomed " to at once adopt measures suited to the circumstances, keeping ever " in view the general purpose of the engagement and the normal order " of battle. They must be prepared to direct the fire and the attack of " their troops to the best effect, and to modify their action, if necessary, " at any moment. For instance, if the enemy's attack were to strike " on one part only of the line, the battalions which are not threatened, " or some of them, should act against his flank. A battalion advancing " must alter the direction of its attack if it finds that it will not bring " it against a suitable object; if it were to strike on two contiguous " bodies of the enemy, it might be necessary to break into two half-" battalions, or, while attacking one body, to bring forward one of its " rear companies on the flank of those in front. Should the enemy " threaten the flank of the first line, he must be taken in flank himself " by the battalion of the second line which happens to be most con-" veniently placed," &c. &c.

" Particular attention is to be given to keeping a suitable distance " between the lines. Occasions may arise when the second line should " be pretty close up; but, as a general rule, its part in action will be that " of a reserve; more especially when, as will usually be the case, " there is an advanced line, 'Vortreffen.' It is only when the imme-" diate co-operation of both lines is wanted that the second should be " near the first.

" A change of lines "—the practice of relieving one line by the other— " in presence of the enemy is to be avoided; and the employment of " the second line deferred as long as possible. The fighting power of " the first line should be worked out. It is secured against disaster " and the enemy's counterstrokes by the second line being kept in " hand.

" When the second line is brought forward, it will as a rule be on " one or other flank of the first, so as to avoid intermixing the regi-" ments. This may often be judiciously effected by advancing it right " and left of the battalion of the first line on that flank which is " hardest pressed; the latter being then withdrawn and rallied in rear " of the other two battalions of its own regiment.

" Brigades and regiments must further be practised in assuming the " formations best calculated to diminish the effect of the enemy's artil-" lery. In view of this, it may be observed generally that formations " of minimum depth are in place under shell, and columns of small " front under case and shrapnel fire.

" The preference for attack which is characteristic of our infantry " is to be kept up and encouraged; and the formations which are suit-" able for the purpose should be much practised. At the same time, " bodies of troops, large or small, must be rendered perfectly familiar " with the evolutions which are necessary to bring out the full effect of " their fire.

" Whenever a tolerably clear range presents itself and a prompt " decision of the fight is not called for, it should be the aim of infantry " to make the most of the great superiority which is enjoyed by steady " troops in position who fire with coolness. The men must, therefore, "be trained to resort instantly, at any moment and in any phase of the "action, to the use of their rifles and to develop the effect of their fire "to the utmost, though perhaps only for a short time and in order to "resume the attack with fresh vigour and larger chances of success "against the shaken ranks of the enemy.

"In fact, the conduct of infantry in action may be said to turn essen-"tially on the judicious application of their fire, concentrated as to "time and place, and on taking instant advantage of the disorder and "demoralization which it will produce in the enemy's ranks."

The concluding sentence contains the pith and marrow of the book. The two main ideas which run through it and underlie its provisions for the attack and for the defence alike, are:—1. The fullest effective use of fire; and, 2. The instant use of the opportunities which it produces.

The theory which used to prevail in continental armies and on which the old Prussian regulations were founded, trusted for success principally to the employment of troops in close order. The effect of fire could not, it was considered, except on rare occasions, *decide* an infantry engagement; it could only introduce and pave the way for the attack of the column, disturb the enemy's formations, make his men unsteady, and render them more accessible to the terror of the charging masses by which the final stroke was to be delivered.

This theory has yielded to the stern logic of facts. It was seen to be obsolete in 1866, when the Austrians strove in vain, clambering over the bodies of their fallen comrades, to grapple with the enemy; but the lesson was not fully taken to heart till Spicheren and St. Privat had urged it home, and proved to demonstration the strength of the breech-loader in position.

Since then a change in tactics has been acknowledged to be inevitable; but the conditions of tactical success remain unchanged. It is as necessary now as formerly to force the enemy to fall back; only the compulsion must be exercised in a different way. The fire of the defence must be turned or overpowered before an assault can be pushed home. The conduct of an Infantry attack in the present day has become in principle the same as that of a regular siege. The converging fire of the assailant must be pushed up under cover—obtained in one way or another—and concentrated on some one point of the enemy's position till that of the defence collapses; then the breach must be instantly occupied and secured.*

It was foreseen years ago† that the change of tactics consequent on the improved Infantry fire-arm would be in this direction. Attention has been pretty generally called to the fact by the works which have been published since the war, and now that it has been registered, as it were, in the new Prussian Regulations it will probably be universally accepted.

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* Cf. Sir G. Wolseley, "Soldier's Pocket Book," pp. 241–3, second edition; also v. Boguslawski, "Tactical Deductions from the War of 1870–71," translated by Col. Graham, cap. iv, pp. 75, *et seq*, and the Translator's preface.

† V. Moltke, "On the Influence that Arms of Precision have on Modern Tactics."

But even now when it is clear enough what is wanted, the path by which it is to be reached is by no means so plain. The only conditions on which it is possible for Infantry to attack a position are, that the men shall be moved forward in loose formation and by degrees, and yet shall be at every moment under the complete and absolute control of the Officers who lead them; and that the latter, *i.e.*, the Officers in the skirmishing line, shall act on their own discretion, and in concert with one another in making the final rush.

It would not be easy to over-estimate the difficulties of the task, and it is evident that the Prussians see them clearly enough. There is scarcely a page—I had almost said a sentence—of the "general "remarks" which does not indicate that they are fully realized and fairly grappled with. Let us see what the demands are, which they make on their Officers and men; and what kind of men and Officers they are on whom such demands are made.

The passages just quoted from the chapters on the brigade indicate what is expected from the higher Officers, and I would only draw attention further to the fact that their duty, according to Prussian instructions, appears to be confined to the general direction of the action. They are not charged, nor are they expected to mix themselves up, with the details of the actual contest, but must hold themselves clear of its inevitable confusion in order that they may the more effectively influence its progress.

The management of the details devolves upon the Officers of subordinate rank, from the Captains of Companies downwards. Theirs is the immediate conduct of the actual fighting, either in first line among the skirmishers, or with the supports, or "Vortreffen" in rear. As regards their duties we find laid down* "Officers and Non-Com-"missioned Officers" in a line of skirmishers "must use every exertion "to keep their men in hand, and more especially to direct their fire. "It is their business to specify the object to be fired at, the distance, "and the sight to be used, and to regulate the intensity of the fire. "They must see on the one hand that the men do not waste their am-"munition, and on the other must recognize the occasions which call for "an unsparing use of it."

"They have to keep their attention constantly fixed on the enemy, "and on the nature of the ground, and to judge how the line, or part of "it, may be pushed forward, whether and how the enemy's flank may "be gained, or an attack made on it. They are expected to seize at "once, and turn to account any opening he may give, and to consider "whether it may not be possible to obtain decisive success by concen-"trating and intensifying the fire of the line on some one point of the "enemy's position, and then breaking, and either dispersing or rolling "up, his line by a quick vigorous charge."

The Officers in second line have the scarcely less difficult duty of keeping the supports and the main body of their companies out of fire, but within reach of the skirmishers, and of feeding the action at the right spot, and in the most effective way. The regulations point out† that

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* Part iv, cap. 17, sect. 108, page 156.

† Part iv, cap. 18, sect. 113, page 166.

"the attention of Officers of all ranks must be particularly directed to "keeping up the connection of the different parts of the line with each "other and with the supports and reserves, and to ensuring the orderly "conduct of the action. In this view it is essential that men of different "corps (companies, battalions, &c.), should not be allowed to get mixed "together. It is to be considered a rule that a body of troops reinforcing "another shall be brought into action on one or other flank; the only "admissible exception is where it would be impossible or palpably mis-"chievous."

So much for the Officers. What is required of the men may be gathered from the closing sentences of section 43 (Chapter IX, page 75). "The company must be able to execute the simple formations and "movements which are necessary in action under all circumstances, by "day or night, in inverted order and without telling off. It must be "prepared to form in any direction, to the right, the left, or both right "and left, on the leading file, towards either flank or to the rear, in close "or in extended order, with perfect certainty and speed, and to change "as quickly to any other formation which the progress of the action "may render necessary. This perfection is not to be attained by laying "down precise forms which tax the soldier's memory. *On the contrary,* "*the company must be trained to such a point that it shall be always* "*altogether in the hand of its leader, and the men's attention must be* "*riveted so entirely and uninterruptedly on his orders that they may be* "*carried out even without previous practice.*"

These are enormous demands to make on Officers and men. They ask from the latter at least all that was formerly required, and in addition, a degree of independent intelligence and mental activity which it has not been usual to calculate upon or even to wish for. The officers of all grades are expected to display not merely such knowledge of their varied duties as may be learnt, but judgment, coolness, untiring energy and vigilance, prompt resolve, and equal readiness to assume responsibility or to lay it down. Such would appear to be the standard to which the Prussians invite their soldiers to attain, and the conditions on which alone they believe that an infantry engagement can be carried through with success. If they are right, if all future fighting will have to be done in extended order, and the chance of victory turn on the greater or less degree in which the officers in first and second line can maintain effective control over their men, and seize the right moment for closing with the enemy whenever it presents itself, we can have no difficulty in admitting that a lower standard will not do, and that it would be absurd to make smaller demands on either officers or men, or to trust them less.

We cannot enter now on the question whether theirs is the best or the only possible solution of the tactical problem, not for their service only, but for others; though these are questions of the first magnitude and interest, and the answers to them cannot be long deferred. But before they can be satisfactorily answered, the conditions must be clearly recognised, on which alone the Prussian solution of the problem is possible. It is idle to make demands on men to which they cannot respond, and I think we may dwell for a few minutes on the singular advantages which the Prussians enjoy, and which justify them in setting up an unusually high standard of training for their army.

I pass over facts which have been amply illustrated on previous occasions in this room,* and confine my remarks to the one point of training. In the first place, there is the high intellectual average of the private soldier, and the discipline of sobriety and obedience to which he has been accustomed in his family and at his school. Baron Stoffel observes† "Pourquoi la discipline est-elle si forte et si sûre dans l'armée "Prussienne? Par la simple raison que les jeunes gens entrent au service "tout disciplinés, c'est-à-dire, façonnés depuis leur enfance à l'obéissance "en général, au respect de l'autorité et à la fidélité au devoir. Il en "résulte que les officiers ou les chefs n'ont presque rien à faire pour "maintenir la discipline et ainsi s'explique par quelle raison on ne "compte qu'un très petit nombre de punitions dans l'armée Prussienne." The recruit joins his regiment ready and willing to learn. What does he find there? By whom is he taken in hand? Who and what are his teachers? They are the officers of his company. I say the Officers, because the first merely formal instruction of the recruit, which is given by the non-commissioned officers, is given under the strict and constant superintendence of an officer; and the instruction, which is not merely formal, which is intended to fit the soldier for the field, is given by the officers of the company themselves.

Thus the young soldier who comes into the service prepared to learn comes at once under the eye and training of men whose intellectual superiority, knowledge of their work, and sense of duty‡, he cannot fail to perceive, and is more or less qualified to appreciate. The brigade, the division, and the corps, are somewhat vague and shadowy conceptions to the recruit; the utmost that they convey to his mind being the satisfactory idea that he is a small unit in an enormous organization of indefinite dimensions and irresistible strength. Nor does he feel that he belongs altogether to a regiment, or even to a battalion, until he has been dismissed drill. But in his company he finds at once, only under a different form, the authorities with whose watchful interest he is not unfamiliar, the old village companions and something even of the loving, and perhaps fussy, guidance of his home.§ He learns to look upon the Captain and his Lieutenants as men who have mastered the whole science of fighting, and who devote themselves to teaching him what they know. We have no occasion to raise a question whether the Officers of the Prussian Army give themselves more wholly to their work than those of other services; it is enough for our purpose to recognise that they do so to an extent which leaves little, if anything, to be desired; and it is also true that their time and thoughts are not taken up by a multiplicity of accounts and returns.|| The whole

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* See Journal, Vol. xv, No. 63.

† Introduction, p. xxi.

‡ Compare Stoffel, "Rapports Militaires," &c., pp. 101, 103–4.

§ Compare Boguslawski, "Tactical Deductions," &c., p. 17.

|| The men are paid and their accounts kept by the Battalion Paymaster; the Company Officers take care that their men get what they are entitled to in pay, clothing, food, &c.

weight of the training through which the troops are put year by year is thrown into the single endeavour to fit them for actual service, and is conducted by the men who will lead them against the enemy when the day of battle comes.

It will be admitted that these are exceptionally favourable conditions for bringing out the necessary qualities, for getting soldiers accustomed to surrender their will to their leaders without sacrificing their intelligence or zeal; and officers trained to lead, not merely to command, their men. But something more is wanted. After all has been done that can be done to place the men thoroughly in their Officers' hands, the standard of required perfection cannot be approached unless the Officers themselves can be trusted to rise to the full level of their responsibilities. We have seen how wide is the range and how difficult the nature of their duties in action; how much is asked from them of cool judgment and of ready daring, of self-abnegation and submission to authority combined with a manly craving for responsibility and an ardent desire for distinction. The task is severe and the training careful in proportion. Its whole aim and essence is to make the Officers complete masters of their work; that work being primarily, if not exclusively, the conduct of their men on the field of battle. Nothing, for instance, is more striking in the management of the Prussian war-schools, through which the Ensigns have to pass before they are commissioned as officers, than the thorough character of the teaching and the extent to which the student is led to think conclusions out for himself. The subjects of study are purely military and the ground gone over in each is limited; but the work within the limit has to be done *bonâ fide* by the student and requires a distinct exertion of the mind. There is absolutely no place for cramming.

Again, the system which makes the Officers of a company answerable for the training of their men provides the best possible training for themselves. It renders them of necessity familiar not only with the individual character of their men, but with the minutest details of their work, and gives them self-reliance and the habit of command.

Lastly, the annual manœuvres, and, in preparation for them, the exercises in company, battalion, regiment and brigade afford opportunities for practising officers in much of the work which would devolve upon them in war, giving them real freedom of action and accustoming them to real responsibility. We find in the official "Regulations for the Manœuvres, &c." p. 8, "the exercises will be useful in proportion as "they give the subordinate officers opportunity for independent action."

If then great demands are made upon the troops in Prussia, they are at least made deliberately and with reasonable prospect of their being responded to. No effort is spared to qualify officers and men for their work by judicious, thorough, and severe training. Opinions will no doubt differ, not so much as to the excellence of their system in itself (though it has not yet been subjected to an exhaustive test), but on the question whether it is suited for other armies. But this much is certain, and it is a point on which it is impossible to insist too strongly. Prussian tactics do not stand alone, they are only one aspect of a very extensive and carefully elaborated organization and are founded on, or rather have grown out of, their system of training. That system exacts more from the troops, and trusts them more freely and fully than is the case elsewhere; it is minute, thorough, and eminently practical, being directed almost exclusively to prepare the troops for actual service, and to link all ranks of the army together by bonds of mutual confidence and respect. I believe it to be essential to the proper working of their tactical principles, and that any attempt to imitate the latter without having first laid the foundation in a training similar to theirs, will result in disappointment, if not in something worse.

I had nearly finished sketching out what I proposed to say this evening, when my attention was recalled by a friend to an excellent little work which dates as far back as 1837, Gawler's "Essentials "of Good Skirmishing." It was revised by the author, Colonel Gawler, formerly of the 52nd Light Infantry, in 1852; and it is curious to observe how much there is in common between the views which it enforces, and those of the regulations we have been considering. Allowing for the difference of armament and the careful way in which the Prussians have worked their system out, we recognize in the most approved tactics of to-day, much of what seems to have been the practice in the old Light Division towards the close of the Peninsular war, when those magnificent regiments had gone through the rough and ready training of eight campaigns. Let us have the closest imitation of such training that we can get in time of peace, let us apply it always and to all our infantry, let men and officers know that it is their real work, that their business is to prepare for actual service, and not for mere parade, and I venture to think that the English Infantry will run no risk of falling into the most dangerous of all delusions, and fancying that real excellence is to be gained by merely copying its neighbours.

The CHAIRMAN: Major Jones has given us so clear, succinct, and at the same time so comprehensive a sketch of the contents of the Prussian Drill-Book, that I think we cannot but feel extremely grateful to him for it. There are many gentlemen present who have made Germany and the tactics of the Prussians their study, so that I hope the lecture will form the basis of observations which they may be pleased to give us. Sir William Codrington, more especially, who lately gave us an interesting lecture on the Prussian manœuvres of 1869, will, I trust, lay before us some of those ideas which Major Jones's lecture will have suggested to him, and which I am sure will give great satisfaction to all present, as illustrating that lecture, and also as throwing fresh light on the Prussian manœuvres so ably explained to us the other day.

General Sir WILLIAM CODRINGTON: It is a very kind invitation, but we come here unprepared, the Lecturer comes fully prepared in writing. There is one thing we must all remember, namely, that every nation has its own individuality of fighting, dependent upon national character, dependent upon conscription or non-conscription, and upon other circumstances; so that we cannot quite put a system for England in a parallel line with that of any other nation. France, Austria, Russia. Prussia have conscription; we entirely volunteers. There is no doubt that the difference in the quality of the recruit is great when tested by this fact. In the Prussian army, and I presume in other armies, you get a mixture of different classes, and an infusion of higher education, that you do not get in the ranks in England to the same extent. Our object should be to utilize entirely those qualities that we find in private soldiers, independent of the consideration whether another army is superior by education or by conscription. Therefore, we cannot apply exactly the same rules that may be beneficial for other nations. With regard to the general question of the tactics of company-columns and columns generally, I understand that the system is changed since the time that I happened to witness it in operation in the peace manœuvres of 1869, in Prussia.

Major JONES: So far changed that skirmishers advance to attack a post in a different way.

Sir W. CODRINGTON: But I apprehend very much on the same principle?

Major JONES: The company column I do not think is changed.

Sir W. CODRINGTON: If so, the same principles are laid down in the drill book now, that were carried out before the war of 1870; because after all the war of 1870 in France is the great test. Certainly, before 1870, I saw—as I mentioned in a lecture here—in four different corps of 25,000 to 28,000 men each, movements of columns under artillery fire that any English Officer would think dangerous to a high degree in war. I was not the only one who saw this, for there were twenty-one English Officers present. It was the subject of conversation and of discussion with the German Officers as well as the English Officers. I did not quite understand from the Lecturer whether there has been a change in distance of the company column and the battalion column. I constantly saw them within twenty-five paces of skirmishers exposed in peace apparently to what in war would be a severe artillery fire, that is to say, positions where artillery would be, and I do not know whether any change has actually taken place in the drill, of which that was the result before the war. Perhaps the Lecturer will be able to tell us what is now the rule; for the means of getting men up to a defensive position, or to troops defending themselves, without the extreme loss consequent upon the use of breech-loaders, is a subject of great interest to English, as well as to foreign troops. There is this also to be remembered, that however good the advance of skirmishers may be, we know that the enemy has skirmishers as well as the party attacking. It does not follow, if you are to attack that further side of the table where there is a defensive position, and your skirmishers advance from this side, that you can get your men close up to that position by commencing in open order, and closing near the enemy; for we may suppose he will have skirmishers equal to those of the attack, and, therefore, it does not follow that you have the movement in your own hands. To have the benefit of open order first, and concentration for main attack, you must get past your enemy's skirmishers before touching his main position. I do not know how the Prussian drill-book now gets over that possible difficulty. If there has been a change, which I hope the Lecturer will be able to tell us, since the war of 1870, it has arisen from the experience of 1870, in which the movement in column under fire, subjected the Prussian troops occasionally to frightful loss. In any question of English lines—in any question of the Prussian system of fighting, skirmishers at the last must form some sort of line; that is to say, they must put themselves in the position for each man to have most individual power, whether that is by fire, or whether by the bayonet. I hope we shall hear with regard to company-columns and battalion-columns, and even brigade-columns forming a mass of six and seven battalions, which I saw during peace in positions liable to artillery fire, whether the new drill has done away with that practice, and with the probability of such losses as took place at St. Privat, Spicheren, and other places. These are the remarks which I think it necessary to offer. If the Lecturer could tell us that there is a total change of system, namely, of not putting columns under fire, and could tell us how the battalions and brigades, I mean the substantial masses of troops, are to advance to a position that is defended by lines and by skirmishers in front of those lines, it would be advantageous to us all. I may perhaps add another question. Would the Lecturer cite, by the experience of the war of 1866 (a successful war on the part of the Prussians), or that of the war of 1870 (also a successful war), a single instance in which skirmishers, as skirmishers, have taken a position solidly defended?

Colonel E. NEWDIGATE: I had the pleasure of being at the same manœuvres as Sir William Codrington, and having taken a great deal of interest in this present drill, I would only remark that the distance between the line of skirmishers of a Prussian battalion and the main body of the battalion is 400 paces, in the regulations for exercise. It would be increased under fire. It is divided in this way. First of all, there are skirmishers sent from the flanks of each battalion. Then comes a small independent support to fill up casualties. Then the remainder of the flank companies, and then the two centre companies, which are 400 paces in rear of the line of skirmishers. That is a great deal further than the distance to which Sir William has referred; but, of course, at all manœuvres mistakes are made. As regards that formation for manœuvre, it struck me at the time as being the best possible formation adapted for manœuvre. If line was required to be formed, as it might be, it would be done by bringing up the rest of the battalion to the skirmishers, instead of clearing away the skirmishers. It takes time and loss to bring formed lines up to where they are required, or to pass from them to any other formation. The small columns were most convenient for manœuvre. With regard to the attack, last winter I was in Germany, and observed the companies at company drill, all under the command of their captains. They practised throwing out men in any direction, any of the men of the company, as skirmishers. Then, for their attack, they always brought up the main part of the company into the centre of the skirmishers, and went through to attack in that way. Their attack was made by the closed body of the company, either formed in line, or, perhaps, in column, which came up to the centre of their own skirmishers, and with them made a rush upon the position. This is what they were practising. The captains were practising this sort of work with their companies almost more than anything else: throwing out any men as skirmishers, re-inforcing them if necessary, but generally bringing up the company in some shape or other in the centre, and going with a rush to attack a position. It seemed to be the chief object of instruction. (Colonel Chesney: You mean in advancing.) In advancing to attack a position. This was only company drill. If I should not be taking up time, as Major Jones has referred to my translation of the drill book, I would mention a mistake that occurs in the passage, "if the intervals *between the files* are too great, another section is sent up." Now, one of the great principles in the Prussian drill is, never to send one lot of skirmishers up into another, but always to send them on the flank of another, either to prolong it in some way, or to fill up the gaps between the skirmishers of one company and the skirmishers of another. Because the companies act independently, one company goes up, another company goes up, and if there happens to be a great gap, they send from the rear company's battalion another independent lot into the centre. I ought therefore to have said, "If the *gaps* are too great, another section is sent up."

Lieut.-Colonel Chesney, R.E.: I wish to ask one question. Do you know if they have given up the practice of bringing up supports in the defence into the line of skirmishers to fire volleys? because that is what I hear from Prussian officers is to be one of the things abolished when they are in advance at all. Do you know whether they do it practically in their drill?

Colonel Newdigate: I think it is abandoned, for this reason, that they have a very strong body of skirmishers in the first line of defence. In that case the fire of the line of skirmishers is as great as could possibly be used. The fire of a close line is a great deal more than can be used. I mean that the smoke is too great. I saw it at the last Brighton Review. The skirmishers, who were six paces apart, were firing so quickly that they could not see what they were firing at. Therefore, the fire of a close line is a great deal too great. It was proved so with the French, they fired away all their ammunition. It is especially in the defence—as it is understood in the new regulations, that this deep formation is of great value, because the supports and reserve being so far back, can wheel to the right or left, and at once form a line to resist a flank attack.

In reply to a question by Sir William Codrington, Colonel Newdigate further explained that from the line of skirmishers to the main body of the battalion in company-columns was 400 paces; that there were two company columns in the centre, and one company column on each flank, (Colonel Newdigate here drew a sketch on the black board) that the outer skirmishers formed the first line of skirmishers; then a small support 150 paces in rear of it by way of filling up casualties in their own subdivision, and then the remainder of the company in two sections, *Züge*. That was altogether 400 paces from the line of skirmishers to the main body of the battalion, which was far more than what they saw when they were at the manœuvres.

Colonel CHESNEY: I think I can give some small contribution to the points in controversy—if that is not too strong a word to use—as to what Sir William Codrington saw in 1869, but I can speak only from hearsay. I went over after the war of 1870, but I was very unfortunate in one respect, as I hardly ever saw any drill in the Prussian Army, but I heard this constantly said, that, before the war, the cry was, "always keep your supports up close to the skirmishers." The idea was, that the moral effect of keeping the supports near the skirmishers was so great, that it far outweighed any disadvantage that they might suffer. But the practical effect of the war was to show that you must not keep the supports near the skirmishers, unless you had cover for them behind. In the same way at the latter part of the war, the distance was very greatly increased. It was found that the troops, at shorter distances between them, could not advance against the French armed with the chassepôt, without suffering enormous loss.

Colonel NEWDIGATE: That partly accounts for the small "supports," because, when Sir William Codrington and myself were there, that little support did not exist.

Sir W. CODRINGTON: Supposing the skirmishers were taken at one-third, which I think was the principle of the Prussian attack at that time; of course, there would be two-thirds of the company in rear as a support. (Colonel NEWDIGATE: Exactly). Then if there were 250 men in a company, and one-third were told off as skirmishers, that would leave about 160 men in a company column of sections; that is to say, a small column of sections. But though a small column of sections, it is a very large mark for artillery. That is what I observed in the Prussian reviews in 1869. And not only was it a mark for artillery, but it was from twenty-five to thirty yards only in rear of the skirmishers; and the battalion the same distance, as it were, from the reserve of the company column. That is the fault, I imagine, that has now been changed by the adoption of these greater distances, so as to avoid artillery fire.

The CHAIRMAN: There is an officer present, Captain H. Brackenbury, R.A., who saw much of the war in his own department, and, no doubt, witnessed the operations of both the armies engaged. I would ask him, if he had the opportunity of observing the Prussian mode of attacks, to give us the advantage of hearing his observations upon it.

Captain BRACKENBURY: It seems almost presumptuous in an artillery officer to venture to say anything on this question of infantry drill. But I think the great point to look at, is the spirit of these Prussian tactics, and not so much the drill formation of any given small body of troops, because the spirit of the whole Prussian regulations seems to be, that any given formation is liable to be immediately varied at the discretion of the Commanding Officer to suit the circumstances in which he finds himself at the moment. I take it, for instance, that this formation of the battalion in a Vortreffen, and Hauptreffen, is as we see it on the board, or as we find it in the drill-book only, as it would be before a single man has been lost. Practically, we find that about one-twelfth of a battalion covers the whole front as skirmishers. Half a subdivision from each of the flank companies with an interval, which, by the Prussian drill, is not to be exceeded, of six paces between the files will cover the whole front; that is one-twelfth of the battalion. Only another one-twelfth of the battalion is there in support. Then, we have one-third of the battalion as the reserves. Then, finally, we have one-half of the battalion remaining in a second reserve. The battalion goes into action like that: its half-battalion remains behind, half sub-divisions going to the front as skirmishers, and other half sub-divisions as supports. What happens when you get into action. The skirmishers begin; then, the skirmishers are strengthened by the supports; the reserves come up to fill the place of the supports; and, then, the main body becomes very rapidly a small column. With regard to what Sir William Codrington has said as to getting through a line of skirmishers, it is distinctly stated in the Prussian drill-book that a position properly held is unassailable in front; and it is laid down that the men are to be taught that a position is unassailable by a front attack. (Sir W. CODRINGTON: Since the war?) The new drill-book has been produced since the war; but I think I am correct in saying it was written before the war, that a position is unassailable in front. As Colonel Newdigate said, the skirmishers are to be strengthened not in front, by sending supports to fill up the line, but by sending those supports towards the flank, I think if you look at the whole spirit of these new Prussian formations, and look at this formation as we see it in on the board, it comes to this: We have a centre; that centre is formed by reserves. The enemy's artillery or the enemy's troops form, we may say, a great circumference with a very long radius, longer than any artillery fire, from that centre. The skirmishers form a chord of the arc of that circumference. Going a step further than the battalion, Moltke's proposal for the formation of an army corps for the defence of a position, is nothing more than that Vortreffen, and Hauptreffen on an extended scale. It is a brigade occupying a front, with battalions in this formation. Then another brigade as a sort of main-body in rear of that; and then a whole division as a reserve. The division in the reserve is the great centre; and so it tells us what is the whole essence and spirit of their tactics. In acting on the offensive, use a small body in the front, and keep your reserves well back. In defence always send the supports to your flank, whichever flank is threatened, because there is no danger to your front, it is your flank which is the dangerous part. Here it seems to me to be exactly the same thing. The whole spirit of this formation is, use a very small body in front, because a line even held by skirmishers in comparatively open order, is unassailable, and keep your supports and reserves for your flanks. Next, with regard to what Sir William Codrington said about the advance of columns under fire. I have good reason to believe that on the 27th September and on the 30th November the working was particularly what the Duke of Wurtemberg tells us was ordered to be done after the 18th August; namely the advance of the supports and reserves to strengthen the shooting line, themselves in extended order, always working in extended order. Now, I believe the object of Major Jones's lecture to-night is not so much to teach us what the Prussians are doing, as to lead us to think a little for ourselves. We have in our own infantry drill the working of skirmishers. I venture to think that the essence of the Prussian skirmishing system, is skirmishing by section; placing in the hand of an intelligent non-commissioned officer a small body of men, so small a body that they can easily be handled and controlled by one man, and can easily find shelter, that man really controlling them. We have lately introduced the system of skirmishing by sections into the infantry service. I believe it will be absolutely necessary for us to train our non-commissioned officers in the duty of skirmishing in this spirit, and not merely in the letter. In our system of attack, let us look at what we do. If we have a battalion in line, we throw out, perhaps, a company of skirmishers, and another company to support; and then the remainder of the battalion moves as a sort of reserve in line. I believe in the Prussian drill an advance in line against the enemy is a thing which is not contemplated, practically not contemplated. Is it not so?

Major Jones: I do not think they positively exclude it; they do not positively exclude anything.

Sir W Codrington: I saw it in 1869.

Captain Brackenbury: I think I can unhesitatingly say that they never advanced in line against the enemy.

Colonel Chesney: They did not in 1870.

Captain Brackenbury: They never advanced in line against the enemy, but the French did. I heard of one or two examples of the French advance against the enemy; and as this question is so much under discussion at present, I thought it might be desirable to be able to quote an instance of an advance in line and the result. I wrote, therefore, to Paris, and I got only this evening, from a senior Staff Officer of one corps during the war, an account of a French advance in line. It is so remarkable that I think it would be interesting to this meeting to read it if I may be allowed. This was at the battle of Rezonville. I will first state the circumstances. It is doubtless known to everybody here that the battle of Rezonville was fought on the 16th August. The second corps was on the extreme left of the French army; the sixth corps was on the right of the second. Comparatively early in the action, the second corps was demoralised by the Prussian fire, and driven back, and it had to abandon the position it held. This, which I will read, is written to me by the first *aide-de-camp* of the Marshal who commanded the

6th corps in campaign, the corps that suffered most in the battles of Rezonville and St. Privat, on the 16th and 18th August:—

(TRANSLATION.)

"On the 16th of August, about one o'clock, at the battle of Rezonville, the Commander of the 6th corps, returning from his right, which occupied St. Marcel, towards his left which rested on the Verdun road, some hundreds of metres in front of Rezonville, saw from the other side of the road a movement of retreat on the part of the 2nd corps, and a movement of attack by the Prussian infantry on the hamlet of Flavigny.

"He immediately directed the 94th regiment of the line to move on Flavigny; then, as much to sustain the morale of his men in presence of the retreat of the neighbouring troops as to aid in arresting the movement of the Prussians on Flavigny, he led forward two battalions of the 93rd, deployed, preceded by skirmishers at three or four hundred metres in front.

"Masked until this moment by a dip in the ground, these two battalions were scarcely out of cover, when they became the mark for such an artillery fire that they could with difficulty pass over a few hundred metres, and wavered (*fléchirent*) under the fire which was crushing them, and in a few minutes many hundreds of men were placed *hors de combat*. This fire proceeded from the great battery established by the enemy in rear, and to the south of Vionville, that is to say at more than 3,000 metres from us, which battery, suspending its fire on Flavigny, had concentrated it on the battalions at the moment their movement in advance was made out.

"This battery was armed with 24 pieces according to some, with 36 according to others, a portion of the guns being covered by a breastwork. At this moment the Prussian infantry were about 2,000 metres from us, between Vionville and Flavigny, and their fire caused us no harm.

"The battalions of the 93rd, which took part in this movement, contained a great number of young soldiers, inasmuch as the evening before the battle, this regiment had received at Metz a contingent of 900 men who had never touched a Chassepôt. Nevertheless, these battalions did not recoil under the fire, though they wavered (*fléchirent sur eux-mêmes*). I doubt if older troops could have prolonged their movement in advance much longer than our young soldiers did, who were led by the Commander of our *corps d'armée* himself."

That is, I think, a very remarkable example of the impossibility of advancing in line under the fire of the present arms. Here are guns at a distance of upwards of 3,000 yards. (Colonel CHESNEY: Or supposing even it is exaggerated). We know the distance by the map, and, roughly, it is not very much out. From where the Prussian guns were beyond Flavigny, it is from 2,500 to 3,000 yards. But, supposing the movement commenced at 2,000 yards, the fact still remains, that under artillery fire alone, without infantry fire two battalions in line lost several hundred men before they had gone some hundreds of paces. In the face of that example, in the face of one or two others which we know, we must seek for some means of having the spirit of this Prussian system of drill, which is the abandonment of anything like a rigid, close formation when once within thoroughly good, active range of the enemy's fire. 2,000 paces is what the Duke of Wurtemberg has stated as being the limit within which troops were not to be moved in close formation. How, then, are we to seek, and where are we to find a new system which will allow us to move in loose order, and at the same time rally at the decisive moment. I believe Major Jones himself is thoroughly of opinion that there is no necessity for adhering slavishly to the Prussian system. (Major JONES: Quite the reverse). The secret is to be found, not in adopting a third rank, not in the adoption of the Prussian company column, but in the adoption of the spirit of the Prussian system; in the first place, in the accurate and careful training of the officers and men, to work in open order and to rally; and, in the next place, in the abandonment of a rigid formation which it is impossible to adhere to under fire—in fact, such a modification of the Prussian system as is suited to our own existing formations. A great deal, I believe, will be found to hinge on a thorough system of section skirmishing. It is not necessary to have three ranks, or to adopt the Prussian drill formations, in order to obtain that.

Major JONES: I think there is very little for me to say in reply to the remarks that gentlemen have been good enough to make. My answers have been to a great extent anticipated by Colonel Newdigate, and Colonel Chesney, and by Captain Brackenbury. I may mention, in confirmation of what Sir William Codrington said, that I have understood that in the earlier actions of the late war, *e.g.*, at Weissenburg, the same fault occurred which he noticed in the manœuvres of 1869, namely, that bodies in close formation did get under the enemy's fire, and suffered severely. One question that I understood Sir William to ask was, "how columns are to approach lines." I do not see that they can approach them.

Sir W. CODRINGTON: I did not ask how columns were to approach lines, but whether their skirmishers in open order had ever taken a position as skirmishers, which was well-defended.

Major JONES: It might perhaps be said that if skirmishers did take a position, it could not have been well-defended. But one side or other must be beaten, and I think we might instance as positions taken by skirmishers in the late war, the actions before Orleans, Le Bouget, Le Mans.* (Colonel CHESNEY: Take the battle of Wörth, the fighting was done by skirmishers). The difference of force was so great that I did not like to quote it. But I think the real question is, not so much whether we can quote distinct instances where skirmishers have taken a position or been defeated; but suppose we have a position to take, how are we to set about it? If we can do it in our old way, with the steady English line, well and good, let us do it. But if we cannot, and our solid English lines melt into thin air, and we lose all our men, as the French battalions Captain Brackenbury has mentioned lost theirs, I should be sorry to see the work attempted in that way. Then, the question remains, how are we to do it? That is the question to the importance of which I have been anxious to direct the attention of Officers who are far better judges than myself. I do not think we can venture to go into a war (at all events with any European nation) without having some notion how that question is to be answered, and I confess I do not think it is at all an easy question to answer.

There was one remark that fell, I think, from Colonel Chesney, which has reference to the Prussian practice in the matter of moving up their supports.

I think the introduction of fire in four ranks may probably have been intended to apply in the case of the supports being brought forward in the defence of a position. The point was whether supporting divisions were ever brought up into the line of skirmishers in close formation. The only instance which occurs to me was in the repulse of Garibaldi's night attack near Dijon, on the 25th November, 1870 (v. Blume, p. 104), where the Prussian outposts are reported to have fired volleys. As a rule I should suppose the supports would be extended before they moved up. But the discretion left to Officers is so large, that no doubt they would be kept in close formation whenever possible; in that case the fire from 4 men from four ranks would be got to bear upon any particular point if concentrated fire was required.† I do not think there is anything further to add. The discussion has, I think, brought out very much what it was desirable should be brought out; and if it has produced the effect of drawing the attention of Officers to the very great importance of the questions which devolve upon us all, professionally, and if we put our shoulders to the wheel to solve them, as I said before, I do not think we need go beyond our own English experience; and I am sure that if there is any infantry in the world which can carry a position in extended order, it is the English infantry. I am decidedly as entirely and absolutely opposed to anything like slavish copying as it is possible for any one to be. I am opposed to it, not because I have any false pride about learning even from an enemy; it is quite the reverse; I should have no objection at all to learn from anybody. But I do think copying is apt to take the spirit out of a thing. It reminds me always of a circumstance that occurred in my own experience in India, where a brother officer engaged a boy to run messages, and gave him a suit of livery, part of which consisted of a large brass plate, with his name upon it. The plate had to be engraved with his name, and in order that it might be done by a native artist, the name was written on a piece of paper. Unfortunately, the writer got hold of a very bad pen, so that the name was adorned with certain "sploshes," which were faithfully reproduced on the brass plate. I think if we are content with simply copying the system of any other army, the probability is that we shall copy the "sploshes" as well as the good points.

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* Instances occurred in 1866 which are mentioned by Captain Laymann in his pamphlet "About Tactics."

† Compare Boguslawski, p. 73, German edition.

The CHAIRMAN: We are very much indebted to Major Jones for the lecture that he has given to us this evening. The discussion that has arisen has been very instructive and suggestive to us. I think you will the more readily join in the vote of thanks which I propose when I tell you that Major Jones's engagements at Sandhurst have afforded him very little time to prepare his lecture or to deliver it. I therefore venture, on the part of this Meeting, to return our best thanks to Major Jones.

LECTURE.

Thursday, July 18th, 1872.

Field Marshal H.R.H. the DUKE OF CAMBRIDGE, K.G., &c., &c., Commanding-in-Chief, President of the Institution, in the Chair.

THE THEORY AND PRACTICE OF PEACE MANŒUVRES, WITH THEIR RELATION TO REAL WARFARE.

By Lieut.-Colonel C. C. Chesney, R.E.

Being abroad on duty last year when the manœuvres near Aldershot were carried on, I cannot affect to be as conversant with their details as many others are. But my loss was in part at least compensated by the advantage of hearing the subject discussed in its widest form by many men of different nations and various views. Having been invited now to lecture upon it, I propose to lay the results of these discussions before you—not without some personal misgiving as to how my remarks may be received by the world outside. For I shall have to combat very popular fallacies, to expose some false yet attractive theories, and to dispel certain rose-coloured but baseless visions which eloquent writers have raised both in and out of the ranks of the Army. It is impossible to tell the plain truth on the subject of these "Autumn Manœuvres" and the limits of their value, without giving offence to some of those who expect from them what they can never produce. But the truth ought not to be kept back, nor the nation be left under any delusion on a very plain matter. I only ask, by way of preface, that I may be believed when I say that not one word of the opinions now offered is the consequence of any humble and mechanical connection of my own with those now preparing for execution. It is not this, but long and earnest reflection on what I have seen and heard on the general subject from those of greater weight, knowledge, and experience than myself, which induces me thus to speak.

It was a practical military man whom we all respect that quoted approvingly in his recent lecture on "Autumn Manœuvres" at this Institution the words of an eminent living authority, "There is nothing "so unlike a real battle as a sham one." Far from disputing this opinion, it is my purpose to enlarge greatly upon it. I would en-

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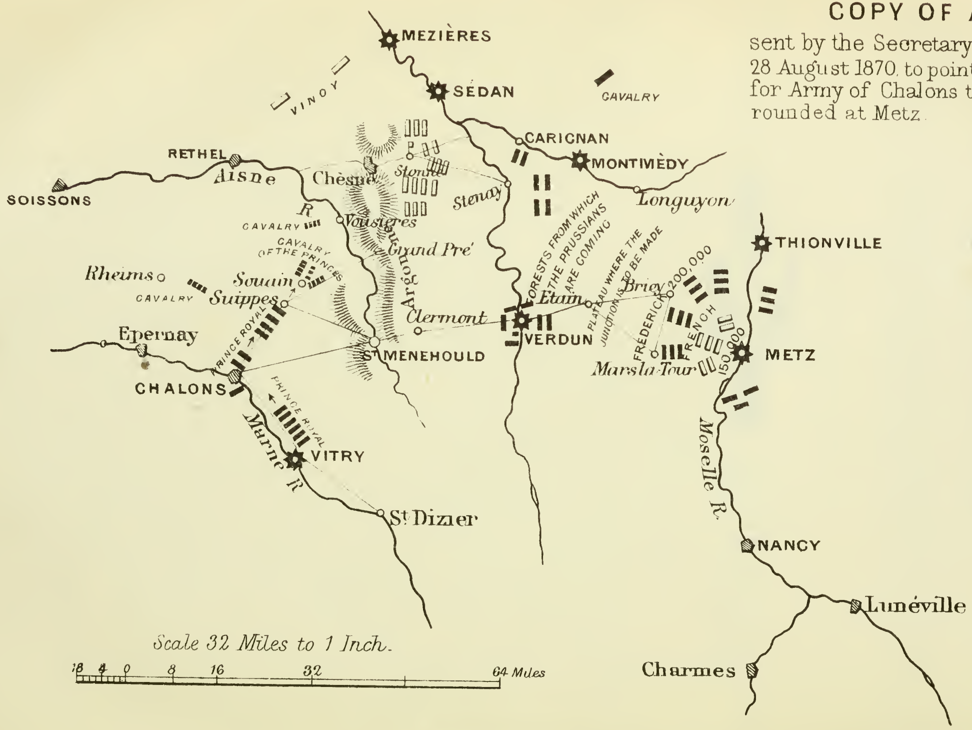
COPY OF A SKETCH

sent by the Secretary of the Minister of War 28 August 1870, to point out movements ordered for Army of Chalons to support the Army surrounded at Metz.



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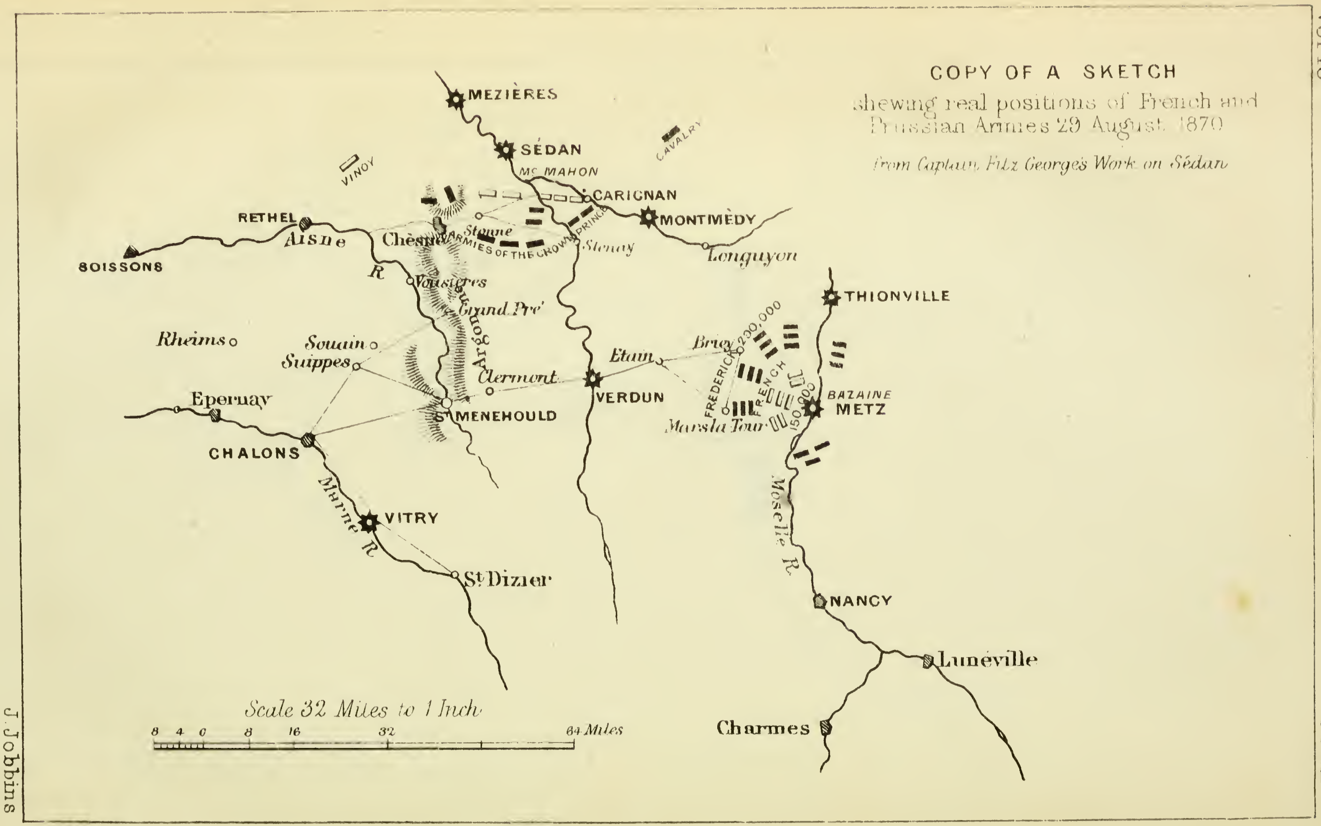

COPY OF A SKETCH
shewing real positions of French and Prussian Armies 29 August 1870
from Captain Fitz George's Work on Sédan

J. Jobbins

deavour to show that the truth it indicates underlies the whole work of the soldier in time of peace; and that whatever pains he may take, and whatever advantage gain for his service by his labour, he cannot approach the dread realities of war, nor do away with the necessity of going for his chief and most useful lessons to the only correct source of military knowledge, the history of what man has done when subject to the conditions of mortal contest with his fellow man. In short, as it was my business last year, at the call of this Institution, to show how the study of military science in time of peace has been one of the chief means used to develop the efficiency of armies, so it is proposed now to follow the same idea out more in detail, and to indicate the danger and difficulties which of necessity await those who imagine that any study however diligent, conducted independently of, and without reflection on the unreality of peace practice, and on its divergence from the facts of history, can possibly be a substitute for the experiences of war and the lessons they bring with them.

The very title of this address points in the broadest way to the distinction which must ever exist between real and mimic war. For look at the former, with its stern use of patriotic sentiments and personal ambition, its hazardous combinations, and unforeseen issues. Consider for a moment the absolute dependence of the best laid plans of the most consummate leader for a successful issue on the faults and shortcomings of an adversary, whose means and mode of action he can hardly guess at, far less control. Mark the untrammelled power with which the military head is clothed under the martial law, which, as our own greatest soldier epigramatically said, "means the will of the "General." And then turn to the uses of peace warfare, even as conducted under the most powerful administration, and you will discover at once that in it are altogether missed, or are but very feebly represented, the most powerful motives and the most frequent contingencies which effect the results of real campaigns. Hence it is that while theory and practice may go so far apart in war that the one may scarcely be known to have resulted in the other, the theory and practice of peace manœuvres cannot, or at any rate need not, thus be separated. In the latter the strings all converge to the same point, and are under the same final control; in the former the whole issue is often as much beyond the actual power as beyond the mental ken of the designer. Let me illustrate this last truth by a forcible instance from facts within the memory of all of us.

On one side of the space before you hangs a plan which is an exact reproduction, save for necessary enlargement, of a theoretical design sent out for execution early in the late war. The fatal days of August 1870, had already broken down almost to ruin the military prestige of the Second Empire. Napoleon's best soldier, the brave old Marshal of Magenta, whose chivalric and unselfish character still makes his name as popular with the French soldiery as in the heyday of success, was rallying at Chalons the wreck of the Army rashly risked against hopeless odds at Woerth. Bazaine too long delaying or delayed on the Moselle, was known to have been actually intercepted in his attempt to retreat from Metz, and the fine words which Count

Palikao used to the Assembly, whatever he meant outwardly by them, did not conceal from himself and his trembling colleagues the desperate nature of the situation. To extricate the Army of the Rhine from the net that Von Moltke had thrown round it, seemed to them the only help in a military or political sense, and their plan for accomplishing it, as well as their view of the general situation, are made clear at a glance by the sketch to which I am pointing, which is enlarged from that drawn in the bureau of Palikao to guide the Commanders concerned. Observe the situation of the German Armies, indicated by no means incorrectly, but the Army of the two Crown Princes, represented as wheeling just too late to intercept MacMahon's march across their north. Observe, too, that the designer is aware both of a cordon of troops on the Lower Meuse and of the presence of the armies enclosing Bazaine. Only he clearly supposed in his own favour the solution of three several difficulties which lay in his way. The Army of MacMahon was to slip past the main body of that of the Princes; it was to break with ease through the cordon of troops on the Lower Meuse; and it was to produce such an effect on the blocked-in force round Metz as to render it certain that Bazaine could push his way through and effect the required union near Etain. Surely in all history there is no more absolute contrast between theory and fact than is shown in the difference between that plan and this, which is taken from the work of Captain Fitzgeorge, to illustrate the facts as they actually occurred. Surely Palikao could have written no satire more powerful on his own ill-conceived and worse executed design than is contained in the simple words scratched on the plan that left his office, "Plateau where the junction is to be effected." Need I recapitulate to any one here the story of those disastrous days which followed the sending out of this sketch on the 28th August, 1870?—the annihilation of MacMahon's Army; the repulse of Bazaine's; the almost miraculous escape of Vinoy, the third concerned.

But what I would bring to the special notice of this audience is that, supposing—which is quite beyond any reasonable supposition that should be made, except for argument's sake—that any nation went deliberately to the expense and trouble of practising great strategic movements like those which culminated in Sedan as peace manœuvres. Supposing, in short, that Palikao had had in his bureau at Paris the final control of the action of all the Commanders concerned, would the events have been in any way like those which history has now recorded? Would one army have been ill-supplied, mutinous, and irresolute; the other well fed, cheerful, and vigorous? Would one Commander have been allowed to overreach and anticipate the other, or his troops to cover twenty miles of ground a day against the other's twelve? Would Bazaine with four corps have fallen back on the 1st of September before one and a half, leaving his work of self-extrication undone for want of serious and sustained effort? The answer is, indeed, too obvious. But the moral of the whole, as I read it, is that no peace practice could in any way match the teaching of war on the grandest scale, for theory in the former overrules and constrains the conditions of practice, which in the latter lead the whole course of events, and in the end decide the result; and if you descend to smaller instances you will but find the same contrast. To teach strategy by peace manœuvres would, even in a modest way, be a frightfully expensive process, as I shall hope to show at a later part of this lecture. It would moreover be tedious and uninstructive to all those concerned save the two or three heads in the secret of the operations, since their part would lie chiefly in long and steady marches; and when taught, or supposed to be taught, it would have been under conditions so different from those of real war that it would be a delusion to think it had made even one good General to add to the national security. But to this subject it will be necessary to revert to more particularly by-and-by.

That of tactics, if not so attractive to the student, can at least be made more intelligible to the general reader, and on that I now propose to dwell at some length; and in tactics it will be found that the rule holds good quite as much as in strategy, that peace practice never will, never can, supply the place of the study of the events of war. Nay, it is possible, keeping strictly within the limits of absolute fact, to state unhesitatingly that no troops or staff, however experienced, can ever be got to conduct their actual contest in mimicry with full attention to the conditions of war. In brief, they never could be so unless one necessary order were given, which even in these days of strong opinions and bold proposals we still hardly hear, namely, to load with ball-cartridge. Those who propose to make a real battle with sham ammunition, and to reason seriously on the lessons it affords, are but preparing disappointment for themselves and those who listen to them. The deep truth holds as good as ever, that in war the moral force is to the physical "as three to one," and when you eliminate from your conditions of battle three-fourths of the whole working power which leads on to victory, such victory as is won can hardly, with any justice, be deemed real enough to be worth the winning.

Lest I be here charged with theorising, I turn to support my statement by certain facts reported recently in his lecture given here on "Autumn Manœuvres," by Sir William Codrington, as witnessed by him in the sham fights of those in Germany in 1869. Here—and I pray this point may specially be noticed—there was no untried Army or inexperienced staff. The cadres at least, with their chiefs, had lately made the victorious campaign of Bohemia, and triumphed over the hardened warriors in whom Benedek and his Emperor had trusted. Moreover, autumn manœuvres had for forty years been practised by the Prussians as a speciality. Their Officers had studied them. Their drill-instructions prepared for them. All conditions seemed to point to at least some approach to reality in the sham battles that were to be conducted under such favourable circumstances. And yet what did the witness of them observe? Artillery playing steadily on regardless of the skirmishers, 400 yards off them, who would have put the battery *hors de combat* in five minutes; cavalry standing still exposed to the same supposed destructive agency at 250; infantry pouring volleys at each other within 70 or 80, the "whole accompanied by many impossibilities, and the fighting the "more unreal as it became closer." Such are some of the expressions I find recorded in notes taken at the time from the narrative delivered by a keen and practised observer. Not that anything here said was said in disproof of the utility of such manœuvres; on the contrary, their value was confessed, but the unlikeness to real war was maintained by Sir W. Codrington, as it probably would be by every thinking man who thoroughly weighs the matter.

Peace Manœuvres cannot teach even good soldiers fully what they have before them in war.—This broad statement—my chief proposition to-day—I hope to prove beyond dispute from the tactical lessons of the late war as now read, and their conflict with the theory of fighting as it was among the Prussians before they had been duly learnt. I trust I may be pardoned the necessary digression for treating fully this important matter. It is true that even now the Germans have not wholly conformed their favourite tactical teaching entirely to the facts they have witnessed, but the latter are so widely admitted that it is but a question of time when it shall be made the rule to act in conformity with them, instead of it being left an exception to be adopted at the will of individuals when circumstances press, under the general freedom of action allowed to German Officers. The point now to be demonstrated is that the knowledge gained is in opposition to the theories used in their peace practice.

There have been during the last century, it may here be briefly stated, but two men who, by the innate power of genius, aided—pray mark the condition—*by the use of its exercise in the field*, have pierced through the coming years with true insight into the spirit of the tactics of modern warfare. Both of these soldiers of prophetic spirit were Prussians.

Eighty years lay between the eras of Bülow's and May's predictions, and in that long interval arose, culminated, and set the star of the mightest warrior that the world has ever seen. Yet great in organisation as he was, in strategy peerless, Napoleon has left no record to show that he foresaw the day when a change in tactics should come suddenly in as great as that with which—chance-found by them, as the secret seemed to be—the revolutionary armies of his early days had met the stiff lines of Frederick. This is the more noteworthy, because it is well known that he was aware of the remarkable saying of Bülow, a saying obviously the result of profound meditation of the peculiar fighting, much of it in cover, he had witnessed in the American war, that "the day would come when armies would be resolved into individual skirmishers."

Bülow said other things as startling and more unpleasant than this in the ears of the paternal government under which he lived, and found the reformer's reward of the day in a prison cell, where he died before the efforts of Napoleon, who alone of his contemporaries recognised the genius of the obscure essayist, could avail to set him free. Bülow's words would have been perhaps but little noted but for his sufferings and the French Emperor's interest in him.

His fate however caused him to be remembered, no less than his keen sayings. His brother too, rose to high command and honour in the army to which the ill-fated writer had belonged, making the world familiar with the name of Bülow in the great struggle which culminated in Napoleon's overthrow. And when, long years after he had stood by our side at Waterloo, the startling effect of the rifled musket in increasing the power of skirmishing was seen at Solferino, the words of his relative, the old Prussian writer, came back to thoughtful men, and made them marvel at the precision which had marked his utterance of an opinion so strange in the ears of his generation.

The breech-loader succeeded the Minié, and Nachod and Kœniggratz came to blot out of history the lesser triumphs of Magenta and Solferino. The Prussians reaped the full advantage due not to autumn manœuvres, nor any other form of drill, but to their perfecting the national organisation for war in the light of the miscarriage on the Rhine in 1859, and to their putting improved arms into the hands of soldiers educated to the point of using them wisely. Almost at every point they triumphed, prepared for victory by the moral superiority which their trust in their weapon gave, and led with a freedom and vigour which only a liberal use of what was meant to be an exceptional part of their older drill could have imparted. Von Moltke, here plainly going before his brothers-in-arms, had publicly counselled in 1865 a freer use of the new famous Company Column than had hitherto been allowed, and his advice was largely followed in the war with Austria, so largely that in the eye of many of the older school of Officers the result was a tendency to disorder. Steinmetz for one, it is known, would not permit his corps to be scattered into these small units so constantly pressed into service elsewhere.

Triumph followed however on triumph, whether the half battalion which he preferred, or the company column, was favoured for the development of the new order of battle. The world looked on and admired the effect, not yet understanding the process. Even those engaged in it were apparently unaware how far their method in practice went beyond the utmost limits of the drill-book, and spoke of the company column as the key of their success with the same belief in its infallibility, and of the impossibility of going beyond it, as any Peninsular warrior ever boasted of Wellington's line.

But this belief was not to last long. From among the ranks of the victorious army arose one whose voice was soon heard and recognised throughout Europe as the true seer of the military visions of his time. Here was one who belonged to those who had achieved the most remarkable tactical success of modern days, and yet, far from being satisfied with what had been done, he boldly treated it as mere proof of the necessity of that complete tactical reform for which he longed, and which in his *Tactical Retrospect* he declared certain ultimately to be carried out, though for a time it might be introduced and then again prohibited. "The extraordinary extension of front with a very small depth," "the confused irregular attack," "the wide stretching-out of the wings," of which Captain May wrote as characteristic of the fights of 1866, he declared were not to be condemned as faulty, but to be utilised as part of the future system. "An army," he went so far as to say, "which cannot venture to trust in the individual worth of its soldiers, cannot reckon on the advantages of the breech-loader." As he wrote these words, and proceeded to illustrate their truth in detail, the French were busy arming themselves with a better weapon than those he had seen in action; but as though the prophetic mood grew on him with his task, he closed his work with the declaration, that in the wars of the future the decisive element would be intellect, not only on the part of the leader, but down to that of the last soldier, and he added the fine prediction that the path of progress in civilisation was that which would make a nation invincible in war. If he be right—and it is well said that his work rather foretold the future literally than, as was its professed intention, criticised the past—then we must reverse, when we think of war, the Laureate's saying, that "the individual withers, and "the world is more and more," and allow that the importance of the individual and his training for personal action—of his whole military education, in fact—is far beyond that which it could have been when the serried line or the steadily moving column, in which each unit could feel his fellow soldier's touch, were the chief means of using the power of the musket.

This digression would be by no means complete for its purpose without putting before my hearers the facts of the late war, as they are represented by indisputable authority, so that it may be seen how little peace manœuvres, such as those of 1869 already spoken of, aided the Prussians in solving the terrible problem before them. It was not by the bold tactics so easy under fire of blank cartridge—not by the direct attacks over open ground on positions well held, which seem to have been rather the rule than the exception in the sham battles witnessed by the foreign visitors in East Prussia—that MacMahon was overwhelmed at Woerth and Bazaine crushed at Gravelotte. The character of the real fighting of 1870 showed an individuality which has impressed itself on all who studied it; and one writer especially has brought its peculiarities out into the clearest light by able generalisation from the facts witnessed by himself and his brothers-in-arms. Need I say that I allude to the work of Boguslawski, that diligent follower in the art of tactical reform of Bülow and May, as well as, it may be added, of Prince Frederick Charles, whose famous essay, the "Military Memorial," has probably had more to do with the achievement of the favourite object of the royal writer, *How to beat the French*, than all the sham battles that the sandy plains along the Vistula ever witnessed during the forty years of peace bequeathed by Waterloo to Prussia. Following out the design of bringing before you what fighting really became eighteen months since, when both sides for the first time carried the breech-loader, I turn naturally to the work already mentioned, happily just translated into our own tongue by Colonel Graham, and so brought within the reach of all. Boguslawski cannot claim the prophetic vision of Bülow, nor the words of fire which made May's work a landmark to the soldiers of his age. He has not, like Prince Frederick Charles, shown the power of applying military theory to the solution of a special national problem. Yet, as a plain practical soldier, writing he tells us, from the ranks, and describing what really happened in presence of himself and his comrades, he is even more valuable for our present purpose. His work has been already read all over Germany, and would have been contradicted a hundred times over did it err in any vital particular. We may say therefore what we please of its lessons. They may be held applicable only to Frenchmen or Germans, only to men of particular race or of special training, yet there they are before us in letters that all who run may read, and however little we may approve of deductions made prematurely from them, as facts at any rate they are too important to be neglected. We will go straight for our purpose to his closing chapter, a sort of summary of the rest of the work.

The tactical action of the three arms together in the field he declares was so excellent in his service that the keenest critics could find in regard to it but little with which to reproach the German Army. Small exceptions indeed may be taken here and there; but they are worth no special notice save from the class of writers who will be positive on every point. From this subject, therefore, he passes on rapidly to the study of the peculiarities of the new order of battles created under the influence of the breech-loader, and to the distinctions noticed between this and that of the days of the First Napoleon.

All direct attacks on a good position must now-a-days, as a rule, be at first repulsed. Assuming this as an ascertained fact, there arises from it the necessity of outflanking the enemy, and this supposes usually a superiority of numbers. With troops of equal quality he observes, however fine the leadership may be, grand strokes of tactical success won with the lesser force are not henceforward to be looked for. For the same reason outflanking to win has become as normal a type of victory in the battles of the present day as the breaking through the enemy's line in those of Napoleon.

The character of the ground to be fought over is at least as important, if not more so, than it was sixty years since. It is probably even more necessary, now-a-days, to possess oneself of its commanding points, for whenever won, artillery fire from them searches a larger space of the field, and it is easier to hold them against counter-attacks than in days before the breech-loader came into use.

As to the actual course of the fight itself, it is opened much as formerly, with artillery fire and isolated attacks on advanced points. But as the artillery contest becomes warmer, a decisive departure from old forms comes into operation, the attacking force striving only to play with the enemy's front, whilst certain corps, told off for the purpose, spread themselves out beyond the wing about to be turned, the cavalry being usually kept well behind, and probably on the flanks. Instead of the decisive attack being now made in large columns covered with skirmishers, and probably culminating in a grand bayonet charge on some important point of the enemy's line, possibly his very centre, it now takes place on the threatened flank with dense swarms of skirmishers, followed up by small supports, preceded by artillery fire, and gaining ground apparently slowly. But if the position be actually turned and carried, the quick firing on the retreating enemy, which forms the pursuit in these days, will be so dreadful in its effects as to make his defeat far more severe than a successful attack of the heavy brigade or division column sixty years since. Often the cavalry will not come into use at all, and even when taking up the pursuit its action will be limited by the still powerful fire of the retreating foe. As to reserves, which formerly had the all-important part of deciding the battle, they have now to be kept so far off that they will not unseldom be too late brought into action at all. So much for the offensive side. As regards the tactics of the defence, the new order of fighting requires that the front line should be made very strong and held at any cost, whilst the reserves, no longer in their old place behind the centre, must be kept in rear of the wings, and constant reconnoitring beyond each of the latter be employed to discover any turning movement of the adversary's as speedily as possible, and meet it by their agency. In short, where concentration for the attack was the rule sixty years since, with the German Generals it has now become extension. And for this there is a double reason—the impracticability of carrying a position properly held with breech-loaders by a front attack, and, which is quite as important, the facility which this terrible weapon, the breech-loader, gives to an apparently extended and thin line of repulsing the counter strokes with which a General of skill in Napoleon's day would have fatally broken through the army that had dared to stretch out to attack him in the modern German fashion.

Boguslawski adds some interesting details of the special changes wrought by the new arms in the use of cavalry and artillery, but he excuses himself for giving his chief attention to the infantry; since the immense losses the latter suffered proportionately to the other arms show how much heavier were its duties than theirs. It has proved itself more than ever the decisive arm; and it may be excused (he adds) if in tactical perfection it appeared not to quite come up to the adroitness of the others, its task being really the more difficult. And in finally considering its special tactical form as now used, he declares it may be comprised in the words, "great swarms of skirmishers and "small tactical units." The experiences of 1859 and 1866, he adds, foreshadowed this; those of 1870, with the breech-loader on both sides, made such a rule absolute. The very notion of leading heavy close masses to the assault, or deploying them to fire volleys in line, is entirely put aside. The individual power of the soldier, and that of the Officer to control and guide him in the fight without losing the advantages of this independent action; that is the quintessence of the new form of infantry battle. If Boguslawski be right, the line and column controversy is settled, so far as his own nation is concerned, by leaving the uses of both in action entirely subordinate to that of the skirmisher, if indeed they be not wholly got rid of. He admits candidly there are certain exceptions to this sweeping rule, but, as a rule, maintains its truth, and declares that the terrible effect of the modern small arm fire practically enforces it, so that he has seen whole brigades dissolved into skirmishers in some of the hard fights of the late war.

It is of course open to us to question the application of these remarks to other Armies. It is certainly not in Germany that the conclusions of the writer are fully adopted; for, among his closing recommendations, are that all movements done in close order should be treated as exceptional; that skirmishing should be taught a recruit almost from his first day, *pari passu* with his other exercises; and again, that skirmishers and supports must alike be trained to intermix with those from other companies or battalions, and to act under the orders of the nearest Officer as readily as though he were their own, just as necessity compelled their doing in the tougher contests of the late war.

It will not be out of place here, to add parenthetically, that much of what is so remarked on, and so strongly recommended just now by the victorious Germans as the key of good skirmishing, appears to have been familiar to the best of our own Peninsular Officers. Anyone who takes the trouble of studying the paper of *Advice on Drill*, written by Sir William Napier for the Volunteers shortly before his death, and largely quoted from in General Macdougall's work on *Modern Warfare*, will at once discover that the principles of combined freedom and discipline were applied in the very same manner by the old soldier-historian, from his practical knowledge gained with the 43rd Light Infantry, as they are in the most recent German work on tactics.

" I told off my men," he says, " by numbers, and practised them to " suddenly run back or advance in the most confused mobbish manner, " either to rally readily or seize an advanced position. The first man " who arrived at a rallying place served as a point on which the others " formed without confusion * * * My command " would be, ' Soldiers, do you see the enemy's skirmishers advancing to " ' that hedge, bank, ditch, rock, whatever the thing might be? Yes! " ' Well, forward at speed and seize it before them.' In an instant the " race and emulation fired them; they used to dash forward furiously " even on parade, and in battle generally gained the ground first. With " this practice your men will soon acquire an eye for good cover, and " * * * will be good skirmishers, provided they " are first taught by other more mechanical drillings to understand " their business as soldiers, and very little will do that." Again, " Suppose you are outnumbered and the enemy begins to outflank " you, your reserves must move out rapidly to advance and oppose " them; but suppose you have no reserve, you are outflanked, you " retreat," words which, though published before the two great and successful wars of the Prussians, contain the very pith and marrow of what the victorious Army has learnt. Indeed, excluding—what is here purposely omitted—Sir W. Napier's check on irregularity by teaching men always to form into their numbered places, as judged unnecessary by German Officers for thoroughly disciplined troops, one might take these instructions, with General Macdougall's just comments on them, that " the secret of success in light infantry movements " is to obtain the speed of irregularity and yet to divest it of con- " fusion," for passages from Boguslawski's earlier chapters and the repetition of them in his closing summary. Where practical soldiers of different nations meet so closely as here, their joint conclusions should be indeed well worthy the study of all military men to whom the improvement of their profession is dear.

But such discussions would carry us beyond the present purpose.

which is to demonstrate that no peace practice of any kind can be hopefully adopted for the purpose of working out the true solution of tactical problems. To put this proposition more plainly. Can any one doubt that it would be perfectly possible to train two bodies of picked British troops, and that without any very long notice, so as to manœuvre against each other at the word, either in simple line and open column, as in the days of Frederick, or line and column with skirmishers, as has been the universal mode from the Revolutionary wars down to our own day, or in the company columns first recommended for more general use by Von Moltke seven years since, and to make in either case interesting sham fights, imitative, if you pleased, of certain well studied actions? But who will pretend to say that any quantity of such practice, carried out with blank cartridge, would possibly avail to tell us whether the Germans were right or wrong in passing on from all these forms to adopt one, in which practically every soldier engaged fights in looser and freer order than any seen since the Romans conquered the world's empire for Rome? For they claim to have established a new order of fighting in which the touch of the next file and the confidence it brings are replaced, as among the Romans they so closely imitate in their training, by the individual power of the soldier and his special dexterous handling of his weapon and complete subordination to his officer. General A. and General B. might practice sham fights against each other for a twelvemonth out of any drill-book given them to work from, and if one be more ready and dexterous than the other, he may find fair occasion to show it. But such problems as that indicated above can only be solved when the breech-loaders send forth their bullets; in other words, they must be studied from real war and not from peace manœuvres. Too much altogether is expected from these for tactics as well as for strategy.

It was but lately, for instance, seriously proposed to attach assistant umpires to all the batteries, who should have power to send off the infantry fired on at long range. Why everything in such cases as these depends on circumstances of which no umpire can fully judge. The most striking differences occurred during the last war in practice from slight alteration of the conditions. At Mars-la-Tour (as we know from the letter of a French Staff Officer read here, on the 24th ult., by Captain Henry Brackenbury) the French 93rd found it impossible to advance deployed in line in face of a heavy battery which struck them down by hundreds, at a distance said to be 3,000 metres. From recollection of the ground, I believe this distance overrated; but the French were on the face of a gentle slope, and so exposed to the full impinging action of the percussion fuze. On the other hand, at Gravelotte thousands of the German shells flew harmlessly over the French as they lay down behind the slightest cover raised or found existing along the crest of the hills they held on both their flanks. The famous walls round St. Privat are as slight erection of loose stone as ever sheltered musketeer. What umpire that would not have ordered Canrobert's troops away, had the fight been a sham one, when ninety pieces raised shell concentrically over the heads of the slender force which held the enclosures? And yet it is admitted that the position was fairly maintained until want of ammunition and the absence of all supports from the reserves shook the confidence of Canrobert's men. Such attempts as that indicated to imitate nature by giving off-hand decisions on the effect of distant fire, would be but to add new difficulties to the old, and to prepare fresh disappointment for those who are so sanguine as to hope to draw from mimic war all the lessons soldiers need. In brief, troops can be trained, and their training largely improved by peace practice, or any given form of tactics; but *the reform of tactics comes by the study of war.* Even Von Moltke's recommendation to develop the use of the breech-loader by developing the use of the company column came after his Danish experience: it may be added that despite that great soldier's foresight and genius for war, his countrymen tell us they have already, under the pressure of two great contests, bettered his instruction, and left the recommendation far behind.

Enough has been now said of the limits which restrict the study and practice of tactics in peace. As to the vaster operations of strategy, your attention has been already directed to the fact that even were the expense of attempting any such so limitless as to put them for our purpose beyond any sober consideration, the result would but be painfully and dangerously misleading. The theory of such a science cannot be worked out with any regard to peace estimates; nor if the restraint which these impose on all responsible rulers were transgressed would the results be at all commensurate with the sacrifice. That this is so has been already sufficiently explained at the opening by a special case taken from the events of Sedan, and this might be repeated indefinitely with the same result of demonstrating that the calculations made for two armies in a single cabinet are in their issue most unlike those made in the opposing councils of two hostile powers. In the latter case only can the real forces which are to produce success or defeat be sincerely brought into play; and it is from such that real lessons are to be gleaned, so far as experience and study can be trusted at all to teach the highest of military sciences.

But it will here be said that those who demand that strategic problems are to be worked out in our peace manœuvres are speaking rather of such as can be managed on a much smaller scale, such in fact as approach in character the minor operations of war rather than those that belong to the higher portions of strategy. It will be our next object therefore to show that the demand, even when put thus moderately, is hardly a well-considered one, and is in truth little more practical than the wildest scheme of a closet theorist for working out an Austerlitz or Waterloo with peace armies. The shortest proof of this may be found in the fact that neither in Prussia, where the system of autumn manœuvres boasts sixty years' standing, nor in Austria, Russia, Switzerland, or Italy, in all of which it has of late been adopted, is there the least pretence of the practice of actual strategy. The same reasons which practically forbid it to ourselves forbid it elsewhere. A few marches to fixed points of collision; sham engagements between two parts of the Army, or the attack of a sham enemy by the whole; movements carried out under general ideas promulgated from day to day, and therefore necessarily restricting the Commanders to very narrow limits; such are the constant features of these mimic campaigns. Analyse what has been publicly written or said of any of the most recent operations of this kind in Prussia. Study the valuable account of last year's Russian manœuvres contributed by Colonel Money to the *Times*. Search the reports of the Hungarian gatherings of regulars and Honveds last year before the Emperor Francis Joseph—an experiment almost as bold as our own admixture of the line with the auxiliary forces. Read (as many here may have the privilege of doing in the official copies) Major Stotherd's instructive narrative of the Italian peace campaign of last autumn. Question—and this I have done very thoroughly in person—the Swiss staff, as to their own experiences with the Militia which forms their only army. In all or any of these examples it will be found that the limits of action are modest and confined far more than many of the ready writers of our journals appear to be aware of. They are in fact no higher or broader than has been already stated. And the reasons for this are not far to seek, though to put them clearly before you a little detail is necessary, the statistical part of which shall be made as little terrifying as may be by being reduced to a brief abstract, which is drawn direct from the best authority.

The pith of what has to be said here is given by Colonel Hamley with his own unrivalled clearness in his work on "The Operations of War." "Two armies," he says, in his chapter on Supply, "are not "like two fencers in an arena who can shift their ground to all points "of the compass; but rather resemble two swordsmen on a narrow "plank that overhangs an abyss, where each has to think not only of "giving and parrying thrusts, but of keeping his footing under "penalty of destruction. The most unpractised General *feels* this at "once on taking command in a district where his troops are not supplied by routine; or if he does not, the loss of a single road to his "Army"—pray mark these words attentively—"would sufficiently "impress it on him."

Now if this be the case with an army in time of war—if "the will "of the soldier," as great technical writers phrase it, be so important an ingredient in the General's calculations when the pressure of real combat places supreme and instant power in his hands, how much rather must this be the case in time of peace? We shall revert to this subject again. For the present it will suffice to say that the designers of peace manœuvres must bear in mind, certainly not less than genuine strategists, the absolute necessity of the integrity of their supplies.

Now we have heard a good deal of proposals for carrying on our manœuvres so freely as to allow the capture of supplies. Have those who talk of such things seriously considered what the words used signify? For some one to capture supplies means that some other is to lose them. And not only would the troops losing them prove very troublesome and unpleasant to handle, if what has been said by Colonel Hamley and others who study the matter has anything in it, but there is another restraining cause of vast weight ever present with our peace operations which absolutely forbids our running the risk of leaving any part of the forces without food or firing for a night. I refer of course to the omnipresent power of the press.

I should be the last person to be slow to acknowledge the immense benefits our Army has derived from that great estate, against the watchfulness of which some of my profession idly chafe, as though it were all evil. It is common enough to say that the Crimean soldiers owed their rescue from prolonged misery, if not from actual starvation, to its beneficent action. And great gratitude is in truth due to what journalism then did for our comrades. But I would go much farther, and assert that it is in great part due to the intelligent interest aroused by it among the nation that we of the Army owe the fact that our profession has never from that epoch been allowed to sink back into any approach to those sad ante-Crimean days, when soldiers were too often regarded as good-for-nothing idlers, things to be hid away by small detachments in obscure barracks, without staff, equipment, or other training than could be given on a slip of ground between four bare walls, as though the country that maintained them was ashamed of its defenders. How this evil tradition arose in England, and why it lasted down to our own time, was a problem which, as all readers of Macaulay's History know, exercised the mind and pen of that great writer not a little. We need not pretend to touch it here. Enough for us that the mighty power of journalism, which some military men are wont to deprecate, has conjured it away with many other superstitions of darker times. Therefore we are greatly debtors to the press, we soldiers. Nor, indeed, should any honest public servant, civil or military, be afraid of fair criticism. But, on the other hand, when watched by such keen eyes as we must expect to be, we have to avoid the very appearance of blunder; and for this reason only, even were it not true still, as in Napoleon's time, that "armies march on their stomachs," we cannot, as before said, allow troops to be left, even for a night, unfed and uncared for. And this they would be too surely, if we played lightly at this game of capturing supplies, with its necessary concomitants.

But why not let the force fall back to get fresh supplies? Lest some one should go away supposing this simple question to be left unanswered, I will proceed to show why this is not likely to be practised. For any real strategic purpose then, such as is suggested by the question, troops cut off from their supplies by being outflanked, or allowing their communications to be cut, will be forced to retire—the proposition is self-evident even to a tyro—on to another line altogether. Now the mere feeding for 24 hours of a force such as is proposed to be put into the field this year from Aldershot of 15,000 men, with its proper complement of cavalry, artillery, and transport, involves the collecting the following supplies, taking last year's scale of provision as a guide:—

Food for Men.

	lbs.	
Meat	15,000	(allowing for waste and offal).
Bread	18,750	
Extra ration of bread for contingencies	18,750	
	52,500	
	450 cwt.	
	Or 22½ tons.	

Food for Horses.

Cavalry and Artillery	2,700	91½ tons.
Transport	1,700	
	4,400	
Average rations for each: 15 lbs. Oats 8 lbs. Hay		

Fuel.

Add wood for 15,000 men, &c., at average of 6 lbs. each ..	114 12½ 126½
	Total weight of rations.

It follows that if the force is suddenly to lose its supplies, it should have over 100 tons of necessaries ready at the point on which it is to retire. But how is this point to be fixed? If the capture of supplies be carried out as a genuine operation, the General must not know from which side his opponent is to come upon him. He must, therefore, have a new set of depôts on either flank. And to continue the same line of proceeding logically, every separate halting place of importance within the area of operations must be properly garnished in case one or other of the armies is forced upon it. For it would be too late to make contracts for the troops when they were waiting to be fed; and if, for argument's sake, we were to suppose that they carry their bread and meat short distances with them, that is, they do *not* really lose their supplies (a supposition which of itself contradicts the theory), then you would still have to bring up from somewhere the greater part of the weight in wood and forage. To do this would involve the hire of 70 waggons a ration, or would cost at a probable payment of 35*s.* per waggon, £122 for every transfer of a day's supply, which would represent the pecuniary fine to be paid if the General retreating did not halt actually at a depôt. But this expenditure would be but a trifling evil compared to the risk run of not obtaining cartage or supplies at all; a risk which carried out into actual fact once or twice would raise—who can doubt it who knows what a press is on such occasions?—such a storm of reprobation round the heads of the luckless authorities who had subjected the soldiers confided to them to unexpected want and suffering, as would almost inevitably result in the condemnation of peace manœuvres altogether.

And here it may be added, that those who desire that our forces should continue to profit by them, should be the last to risk their continuance by wild demands, compliance with which would put upon the War Department a burden of expense intolerable to the nation. To carry out strategy proper with peace forces could only be done, as just indicated, by forming depôts all over the country to be used so as to imitate the supplies which requisitions would produce in war; and to adopt this principle would raise the contemplated expenditure of about £100,000 to five-fold, ten-fold, or twenty-fold, without covering a sufficient area of country to meet the views of such projectors. But when this is said, all is not yet said. For if the nation and administrators were so wild as to try the experiment, the result would be doubly unsatisfactory. The greater part of the forces would be kept at marches to them apparently objectless and wearying, without the compensating excitement of real war to support them; and the half-dozen Officers trusted with the secrets on either side would carry out combinations, the true results of which at the points of collision would never be ascertained, for the reason already given, the unreality of all peace tactics.

To sum up the results of what has been said, the extreme limits of action in such manœuvres, as connected with the supply question, are, in fact, a movement forwards or backwards for a single day's march. Lest this rule should appear too stringent, it may be stated here that an analysis of all the recent peace campaigns recorded will confirm this to the most incredulous who is at the pains to make it. The most extensive impromptu movement made in any of these was in the Italian practice of last year, as recorded by Major Stotherd, when the defending force of General Longone suddenly fell back from Lonato, a march of nearly twenty miles, transporting its supplies with it, but making no lateral change from its line of operations.

Cooked rations carried by the soldiers are so favourite a device with those who plan campaigns on paper, that it will to many seem necessary to allude to them. Happily it is not needful to enter into a lengthy discussion of the subject here, or to offer an opinion of my own as of weight against the advocates of the experiment. It will be enough to lay before you what is said on this head in a recent article in *Blackwood*, which is well known to be from the pen of a Staff Officer who has seen real hard service as well as peace manœuvres, and who has an hereditary right to be heard on any matter that affects the name of our Army. A word from such an authority is worth an hour's theorising from those who do not practically know what men can and cannot do.

"It is quite true," says this writer (arguing against a proposal thrown out last year that the troops should carry their own food for one or two days), "that it is occasionally necessary to order the troops "to carry their rations cooked with them, because it sometimes happens "that they cannot get in until late at night. But this is an exceptional case, to be met in an exceptional manner; and on the principle "that they had better on such occasions receive (what it practically "amounts to) a half-ration rather than no food.

"Every army has its own peculiarities, which it is in vain to contend "with.

"One of the most prominent ones of the British Army is, and "always has been, that to keep the men in health and strength you "*must* carry their rations for them, and issue them daily on the spot.

"And these national peculiarities are stronger than official red-tape "rules and the convenience of departments.

"Besides, there is little use in trying to diminish the burden of the "soldier's kit, if you simply more than make up the weight of his "necessaries and comforts taken off by heaping on his aching limbs "what the Control should carry."

It is vain, let this be said as plainly as possible, to chafe at the limits which facts impose. It is as absurd to complain that those who design a peace campaign have to study the daily necessities of the troops that are to be employed, as it would be to grumble that the men did not march thirty miles in a day because it is known that such a distance has been accomplished by a division under special circumstances. I have but slightly alluded to the consideration of expense, so closely involved in this question, for on this point most will agree with me that statesmen who are answerable to the Parliament and country are more likely to be right in their judgment of what is fit and acceptable to propose, than any irresponsible writer, however well-intentioned.

If, then, strategy cannot possibly be scientifically taught by peace manœuvres; if the tactical portions of these, however interesting, are of necessity so unreal that they cannot guide the wisest leaders as to the future; are we of necessity to conclude that the value of such practice is either none at all, or is greatly over-rated? Nothing can be further from our thoughts than to suggest any such solution of an inquiry as this. On the contrary, it is my firm belief that no other training, however careful, however intelligent, can wholly replace that gained by what, though it be but a form of exercise—or, if you prefer it, of drill—is so much the highest and most instructive form that all others should be regarded as designed to lead up to this large and more combined action of the army. To the fullest it will be found that our English writer is correct in stating at the opening of the *Blackwood* article, "The Autumnal Manœuvres did immense good; "and they promise, if regularly continued, to do more." In Italy, Major Stotherd's testimony, as gathered from the most experienced minds upon the Staff, is that the spread of intelligence among the Officers and men, and of subordination to authority noticed in the army of the young kingdom, is in great part due to the effect of such manœuvres. In Switzerland, I have been assured again and again, that the semi-volunteer semi-militia forces of the Cantons take an interest in them, and go into them with a heartiness of spirit which is by no means universal in the isolated training of battalions that the law more usually enforces. In Austria the most unfortunate, and yet often glorious of armies, appears to hope more from them than has been gained by the bitter experience of defeat in successive wars. As to Prussia, the words of Boguslawski on this subject express the general sentiment of her Officers :—

" For the last sixty years we have, fortunately for us, held to our " peace manœuvres. Every one now admits that it was owing to " these that our Officers and soldiers gained during the long peace an " impression, as nearly correct as was possible, of war, and made at " least an approximate acquaintance with the actual hardships of " warfare, and with the art of making themselves at home in a strange " country upon bivouac."

It is hardly necessary surely to add to this weight of opinion ; but I beg those who still doubt to remember the fact, all-important to the moral tone of our Army, that these manœuvres are absolutely the only training troops ever can have which will enable Officers thoroughly to know and be known by their men. For these two classes may spend a lifetime side by side in barracks, and yet come out of that experience utterly ignorant how far the one can rely on the other in the field. Does any one suppose that before the late war there was a single Officer so cognisant of the sad state of the French infantry as to be prepared to learn that on the first day's retreat of Douay's corps —the enemy being not only unseen, but at the time a week's march from them—700 of his infantry threw away their arms ? No wonder that his Staff blushed when not many days ago after they found themselves at Chalons, the Aldershot which the French army had made the measure of its highest practice, and remembered how often they had trod its plain in sham fights, unconscious of what demoralised stuff their troops were composed ! Demoralisation is confined to no army, no race. Witness Hohenlinden, and the great Archduke, chief worthy to be ranked with Wellington and Napoleon, despairingly seeking a truce at any terms, because unable to check the flight of the once victorious battalions to whose command he had been brought back too late ! Witness Jena and the sons of Frederick's unconquerable warriors laying down their arms by hundreds at the shout of the pursuing cuirassiers ! Witness the sad story Napier has given us for our warning of which British soldiers did on their sullen retreat from Burgos ! Witness, again, Bull's Run, where men who afterwards followed Grant and Sherman to unhoped for triumph over an enemy deemed invincible, behaved like some street mob stricken with panic terror. But it is impossible that demoralisation should exist so largely as to come before battle, before defeat, almost before retreat, as it did in the Imperialist Army of 1870, if the Officers had been accustomed to rough it honestly side by side by their men in peace manœuvres. For had these been regularly tested, the disease must have come to light, though no one can now surely say whether there was power under the Second Empire to remedy so dire a malady.

This subject bids me speak of another limit imposed naturally upon all those who conduct peace operations. We hear of proposals for long-continued contests to be thoroughly fought out, and decisive victories to be won, even to the destruction, acted of course, of one force engaged. These are, and will be, but dreams. Such triumphs as are obtained by pressing a beaten army hotly from day to day are not desirable, even were they possible, in peace manœuvres. There could be none such, whilst human nature is what it is, without bitter rankling of mind, sharp accusation of those in authority, and an unhappy legacy of fancied shame on the part of those who were to enact on a smaller scale the share of Mack's, or Macmahon's, or Bourbaki's forces in their calamities. Indeed any one who attempted such operations would be left on the horns of an inevitable dilemma. Either the troops intended to be thoroughly beaten would get out of hand in their eagerness to rescue themselves from what would appear to them discredit, or, if forced along before the mock pursuer by the power of high discipline, they would be tempted to imitate the practices of a retreating army, and demoralisation is so very ugly a thing that, like certain vices, it would prove unsafe even to act it. This reason alone is sufficient to account for the universal prevalence of the wise rule, that in peace manœuvres *there must be a fresh programme, or general idea laid out from day to day.*

How is this rule to be best carried out? for that is our next inquiry. It is obvious that to attack and defend the same positions, or make the same marches over and over again, can be but little instructive. For this plain reason it is usual, when the forces are come into collision, to terminate each day's operations with an enforced retreat of one body to a fresh position, where the engagement is probably to be renewed. It is of course quite possible that the attacking force may of itself accomplish this by the success of its movements that day, when the defenders would naturally retire on the selected position beyond. But suppose the attack fails, it is still necessary, for reasons already enlarged on, to carry out the general programme, and this may reasonably and properly be done by inserting at this point a theoretical cause—from something supposed to occur outside the actual field of operations—why the defending force, though receiving proper credit for a temporary success, should fall back.

As peace campaigns cannot be carried out with the main bulk of the forces of any army, it will be but consistent with common sense to treat them in all cases as either outside of or subordinate to larger operations understood to be going on in other parts of the country, the results of which would, of course, affect them. It is by bearing this leading condition in mind from first to last, and in no other way, that the manœuvres of a few divisions can be made on any plan to accord with any conceivable contingencies in which such moderate forces would play a serious part.

It is not here, however, to be forgotten that there is another way in which a programme may be carried out of itself with less apparent dictation than under this system of constant control. This is the simple expedient of making the defending force so seriously inferior to the attacking, that it is certain the latter can outflank it and drive it

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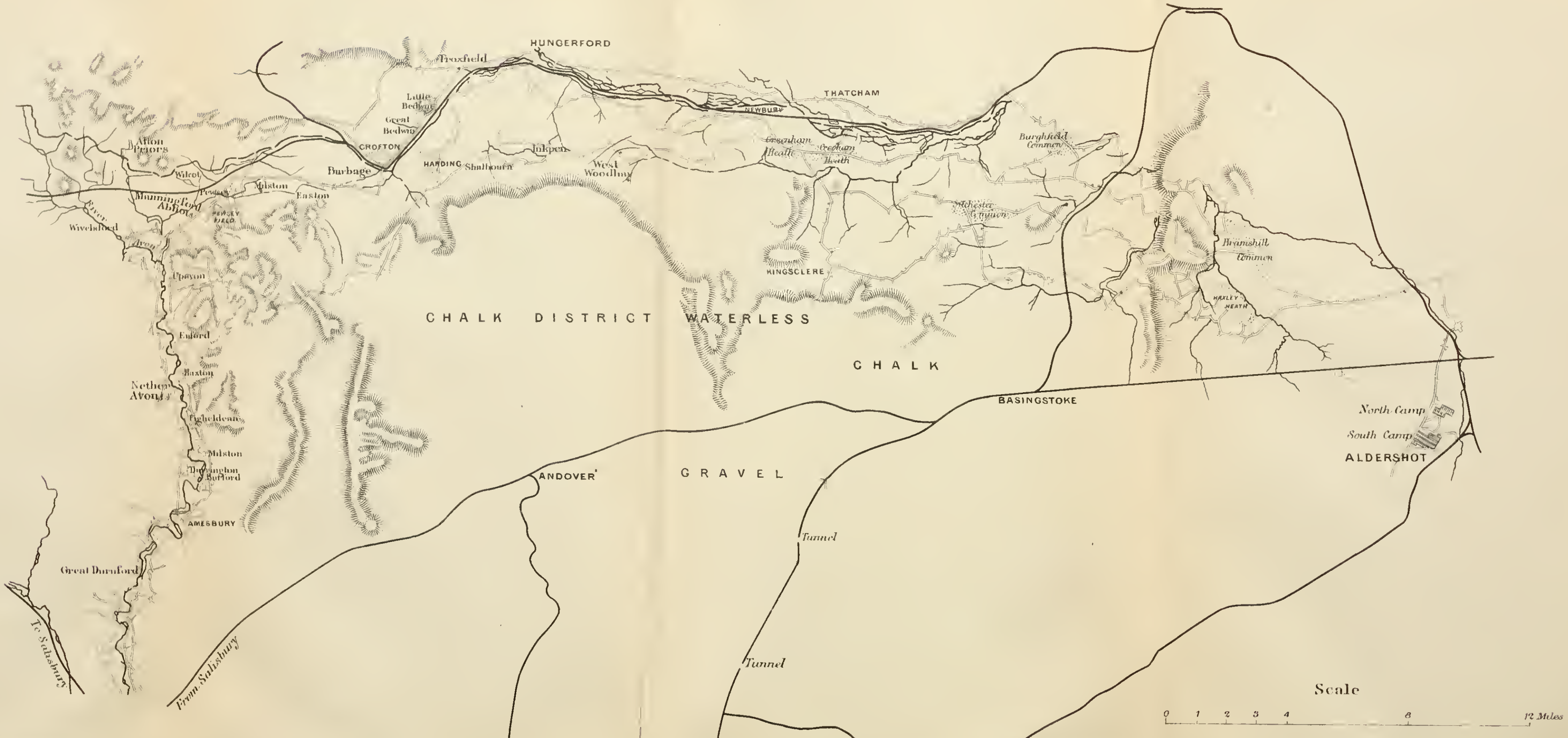

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back from point to point as the chief operator designs. This was the plan adopted last year by the Italians. But it is quite a mistake to suppose that it makes the whole affair more real than the struggle between two equal forces, of which one is bound to retire by order, for every tyro of military science knows that a continued retreat before a very superior force, if the men and leaders be fairly matched, is so dangerous and expensive an operation that the lesser must rapidly diminish, and if not soon reinforced—such at least is the general rule—will infallibly be destroyed within a given time. Now it has been shown why no peace army intends to practice anything approaching such destruction. The supposed reality of this method of unequal division has, therefore, no sound basis to rest on, and it can certainly claim no inherent superiority over the other, the retreat by order "for "a strategic purpose," MacClellan's historic words being here put to their strict and proper use.

Viewed in this light the operations, so far as known this year, have in them nothing of the extraordinarily improbable. That an enemy attacking this kingdom seriously should lodge a small corps in Dorsetshire expressly to divert our attention from the main invasion; that a reserve of regulars, maintained at Aldershot in case of such need, should be moved to Salisbury Plain to check it; that the former should halt at Blandford Racecourse—where he strikes on the open country—to collect his long columns straggling through the rich and closely cultivated vale behind him; that the defenders should pause when they reach the Plain, before quitting the railroad near Marlborough, to receive their reinforcements of auxiliary troops hurried down from the north; that they should then move across to await their foes advancing from Blandford in fighting order in the strongest position that he can find; that both armies should avoid the city of Salisbury—the defender, in hopes to spare its close streets and unrivalled cathedral from the dangers of shot and shell, and the invader, because he has heard of certain strong earthworks thrown up hastily round it and manned by volunteer gunners; all these suppositions are at least possibilities. But it is quite impossible that England should be seriously invaded or seriously defended by 15,000 men. No imagination—not even that of the writer of the *Battle of Dorking*—could create a mortal struggle for our empire between these numbers. It will be both simple and best therefore to view the Salisbury campaign as a mere outlying portion of some larger and more serious operations—happily only in our case to be imagined, and therefore easily conducted to a peaceful and happy close.

And now let us pass from the abstract to the concrete; from theory, which we can manage at will in the closet, to the facts to be dealt with on the ground. Let us take but one practical example of the difficulties which beset all our efforts at mimic war, just to show what indulgence they must inevitably receive from any fair critic who studies them in detail closely.

It is proposed this year to march one force at least to the scene of the encounter. The Aldershot one being nearly ready made is naturally chosen. The distance from its quarters to Pewsey, the most accessible part of the Plain, is under 60 miles in a straight line, as shown by the map. The apparently simple problem of moving it has to be worked out. Now it cannot move direct, since its march would carry it right across the northern part of the great Andover and Basingstoke plateau of chalk, a district absolutely waterless, except for a few poor expensively made wells. Every mile north of the Kennet River on the other hand would carry it into a closely cultivated country, and take it so much further out of the way. The march is practically fixed therefore at once to the valley formed by the Kennet and its tributaries. For water is still a requisite of life, as much as when poor Lever's Colonel Monsoon found to his cost (readers of *Jack Hinton* will recall the passage), that Wellington entirely objected to his excuse for leaving his division without any, "that Providence didn't make rivers "run uphill." If our troops were left without water for the night we should find, I fear, that the British Army's staff is supervised in these days by eyes as keen as those of Wellington; nor do all the press writers know as well as the great Duke what the practical difficulties of field supply are.

Water is but one of these. Your troops must each night have space to camp upon (and eight and eighty acres are the very least required for a complete force of 15,000 men), food to eat, forage for their beasts, and wood for firing. Now the map will tell at a glance how limited are the facilities as to the first. It is drawn to show all the important open spaces in the Kennet Valley likely to be of any use. They have been carefully looked at, and it is found that every one will have to be used in the necessary five days' march, with one single exception only. Nor in this careful preparation, and those made for the supplies at these halting grounds, nor in the march performed without opposition—yet probably, for all that, with such precautions as any good Officer would insist on from the first for practice, though he would know perfectly well his foe was still in Dorsetshire—is there anything really inconsistent with what would have to be done if the occasion arose to meet a real enemy. All the preparations now made would then be made equally, only more hurriedly, more roughly, and of course more expensively than there is any necessity when the want is foretold and foreseen exactly.

Thus far it has been my chief, and not always pleasant, task to point out what peace manœuvres *cannot* do for us. It was needful to do this plainly; for the public has been somewhat over-sanguine, and the military world over-ambitious of results which cannot be realised. It is well now, on the other hand, to indicate certain problems which they may help in solving, besides reminding you of their proved moral value to the Army, lest we be discouraged in our pursuit of knowledge by this patriotic means. For patriotism on the part of many persons is implied wherever peace manœuvres are effectively carried out. There must be some sacrifice of individual wish on the part of those outside the Army in order to effect the object. As for those in it, it is enough here to say on their behalf, that because our aim is modest it need not the less be thorough.

In Organisation, then, first. Such manœuvres regularly carried on should at once enable us to discover whether we can expect any military perfection from an army which has its staff separate altogether from the regiments that come under it until they meet on service, as with ourselves, and the French, and the Swiss; or whether the Germans are right in saying that a divisional and brigade staff attached permanently to the troops is an absolutely necessary element of military efficiency.

We may study, too, whether it is better for our Army to adopt the Army Corps system of some other countries, or whether an equally complete and effective military system in a moderate army cannot be obtained by forming and keeping a combined division in such districts, the Divisional General having all the necessary powers, as the Corps Commander elsewhere. It is an absolute delusion to suppose that decentralisation has any necessary connection with army corps. It has been worked out by army corps hitherto, but this simply because the problem of decentralising by divisions—to be united arbitrarily into Army commands for war purposes, just as the Germans now find they must their numerous corps—has not yet been fairly tried.

The great supply question, with its important disputed points—notably as to whether the General's Chief Supply Officer—Controller, as he is now termed—is to deal direct with him, or with a head of staff—is essentially one to be tested in peace manœuvres. So, it may be added, is that of whether the Supply Department, as existing, is thoroughly qualified (if not, it clearly should become so) to feed a force locally where local means are fairly purchasable.

In Tactics. Not merely does this practice give better opportunities of working combined divisions, our present fighting form, than any single camp could, but there are certain unsettled problems here, too, which may be ventured on without testing the solution with bullet or shell. Such are, what is the best size for an infantry brigade? Can we dispense with the Regimental Commander, or Sub-Brigadier of the Continent? How far can artillery be worked under the General of Division's own direction?—a problem, the answer to which in Germany just now, is very different from that which is popular with our own artillerists, who are seeking the complete independence the Germans want to get rid of, in order to be an integral part of the division. Again, would it be better to keep field artillery always field, and garrison gunners always with heavy guns?—another problem which is likely to be differently answered in Germany than it is here the fashion to reply to it. Are our engineer companies, composed, as they are, solely of trained artificers, who have at some time had an elaborate schooling in siege works, properly fitted for the more rough and sudden duties of field engineering? I have purposely not referred to the outpost duty, reconnoitring, camping, marching, and cooking, which must be practised, because everybody is agreed in admitting their advantages.

Lastly, in a national point of view these manœuvres must be of the highest value, were it only that it is by their means chiefly we have to settle those most important problems of all—what training do our auxiliary forces require? *And what is the particular help we must look* *for from them in case of war?* These great subjects I pretend to do no more here than to point to. We shall, at any rate, in peace manœuvres learn to study thoroughly the national uses of our open spaces, and find out where they lie, so as not to be forced, as in Switzerland, to manœuvre over and over again in the same district. The sad and somewhat discreditable ignorance of the soldier which exists in many of our rural districts—there are persons lately heard of, living within *two* days' ride of Aldershot who seem to regard him as an untameable and dangerous wild beast—will vanish as we use this simple means of advertising the Army, the excellence of whose regimental Officers the keenest critic of last year's manœuvres, the able *Macmillan* writer, expressed his surprise at. And I am very hopeful, from the reception the movement has hitherto encountered, and the public spirit manifested towards it by so many persons, that proprietors will each year put fewer and fewer difficulties in the way of the Army's best training, and learn to look on it not as a nuisance dangerous to property and game, but as a wholesome and salutary national exercise. And to those of my more quiet-loving countrymen who still object, I would say,—it is not we Englishmen who are the cause of our own arming. It is not we who have turned Europe into a standing camp, and made of peace no better than an armed truce. Our hands, in an international sense at least, are pure of our brother's blood.

Foreigners, too, will come here prepared to note our deficiencies, and will, doubtless, see many shortcomings; but they will see also some compensating advantages. It was not without some feeling of national pride that I could point out at an Aldershot field day recently to a strange Officer from Germany who rode beside me, the wealthiest peer by repute in all Europe doing his Colonel's work right ardently at the head of a volunteer battalion, in the dust and glare of the Long Valley. Aye! even in the very feudal formation of our Militia, and the citizen-like gathering of Volunteers there is a great lesson to be learnt; and failing, happily, the test of war, peace manœuvres will teach it best. It is that in this money-getting and peace-loving England of ours, which continental publicists affect to despise for its pacific feeling, and Communist adventurers intrigue to upturn, there are yet left many who are not content with only increasing their stores and making larger garners to pile them in, for the use, it may be, of the stranger; but who desire to hand their possessions and their liberties down intact to their children's children, and who are ready at need to stake their lives at their country's call that this first duty of the patriot may be fulfilled.

The CHAIRMAN: Gentlemen, on rising to express to Colonel Chesney the thanks of this meeting for the interesting lecture we have just heard, I am glad to have an opportunity of endorsing some of the opinions so ably stated by him. I shall certainly not attempt on such an occasion as this to go into the details which have been so clearly and definitely brought before you on the subject of these annual (or at all events occasional) peaceful manœuvres, but I am happy to have the opportunity thus afforded me of stating how entirely I agree with what the gallant Officer has stated as regards the difficulties connected with "peace manœuvres." In fact, in some respects—singularly to say—"peace manœuvres" are far more difficult to carry out than the operations of real war, and for this simple reason, that in the one case you have a definite object, and any means may be taken to effect that definite object; in the other you can do nothing but take such means as are afforded you without trespassing on the rights of proprietors. In a luxurious and highly cultivated country like England, in order to make these manœuvres at all possible, we must be extremely cautious how they are conducted, for it is only by conducting them in a manner acceptable and agreeable to the country itself, that they can be at all maintained; and if we attempted to carry on these manœuvres as they would be carried on in real warfare, the result would be that you would see no more of them. The next thing to be considered is the question of "facility of movement," and I am very glad to have the opportunity of making a remark on that subject, as it was constantly thrown in my teeth last year that the Officers were so terribly confined by the plans of operation that they could neither show their own ability nor the endurance of the troops under their command. All I can say is, that if I were to say to Commanders of two corps of 10,000 or 15,000 men "You may act just as you like, the one against the other," and I did not restrict them at all, the chances are, that both forces would be starved within 48 hours, and everybody would be crying out "What are the authorities about to allow such things to happen, so that horses and men are positively without food in consequence of the want of management at the head of affairs?" The fact is, we have to carry everything with us. We may be within a few yards of a large wood, but we dare not cut a twig, if we did, we should be immediately indicted for trespass. However simple these matters may seem, it is not everybody who can appreciate them. And now with regard to "food;" in war the cattle are driven along with the army, and when you come to your bivouac you kill your oxen and eat them, but what were we obliged to do last year? Every single particle of meat which the troops required had to be brought down from London, because the act which exists with regard to the "cattle disease" does not allow us to drive cattle along the roads. Then as regards the "supply of water;" the map before you shows you what difficulties there are about water on the line of country between Aldershot and Salisbury Plain. Now, of course, we cannot go away from our water supply. It may be that on our right and left we have fine tracts of open country, and people say "Why do not the troops go over those fine tracts of country?" But you cannot do it, and why? Because you get away from your water supply, and both men and horses would suffer. These are reasons which oblige me, if I am in command, instead of saying "I will have my camp *here* and *there*, because we will finish the manœuvre there," to say "No, the troops must retire and march to such and such places," because those are plots of ground which have been examined, and are found to have a good water supply, and because, in addition to that, all the supplies have been brought to those points. I have great pleasure in entirely endorsing what has been so ably and so judiciously put forward by Colonel Chesney, and I trust that I may be permitted, on the part of this meeting, to express our sense of the very able lecture that he has given.

Evening Meeting.

Wednesday, May 15th, 1872.

General Sir WILLIAM J. CODRINGTON, G.C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between the 8th and 15th May, 1872.

LIFE.

Maclear, John, F.L.P., Comr. R.N.

ANNUAL.

Radcliffe, Henry, Capt. South Middx. Rifle Vols.
Paterson, H.W., Capt. h.-p. 4th W. I. Regt.
Gunning, C. G., Capt. Madras Staff Corps.

OUR NAVAL AND MILITARY ESTABLISHMENTS REGARDED WITH REFERENCE TO THE DANGERS OF INVASION.

By W. Vernon Harcourt, Esq., Q.C., M.P.

The Chairman: Gentlemen, allow me to introduce to you Mr. Vernon Harcourt, who is to lecture on a subject that is interesting to all members of the Military profession; but Mr. Harcourt knows that we are not a political assembly, and that the subjects that are mooted here are those which relate to the defence of England, and to the various subjects connected with the naval and the military services of the country.

Mr. Vernon Harcourt: This is the second time that I have had the honour of standing in this place. The first time by the invitation of the Council of this Institution, when I was asked to make some remarks on a question which is not yet concluded, but which is of great interest, viz., the question of the "Alabama Claims." That had to do with a matter of international law about which I might be supposed to know something. To-night I have been invited by the Council of the Institution to make some remarks upon a subject about which I may be fairly assumed to know nothing, viz., "naval and military affairs," so that when I received the letter from your Secretary asking me to give a lecture here, I must confess that I looked at the date with some surprise, and wondered whether it was dated on the 1st April. I was rather disposed to write back an answer and say, in the terms of the old proverb, that the cobbler ought to confine himself to his last. But, upon further reflection, it did occur to me that, after all, the questions discussed in this Institution are questions which affect not military or naval men alone, but the interests of every class of the community; and that if it were possible to introduce even more than exists at present, a system of intercommunication of ideas between the civilian and the professional elements in the country, it would be of great advantage to all persons concerned—as well to the naval and military professions as to the public at large. Therefore, when I accepted the Council's invitation I accepted it in this sense: I thought, though I could not come here to teach, that I and many others who feel like me, might come here and learn a great deal by propounding to the scientific members of the military profession, of whom this Institution is mainly composed—and one of its main objects is, I suppose, to lead to the interchange of ideas amongst them—to propound to them certain questions about which we know nothing and about which they know a great deal, but which seriously affect the interests of the nation at large. Therefore, when I accepted the invitation, it was strictly in my professional capacity, because the business of a lawyer is not so much to know anything himself as to endeavour to extract information from others, sometimes by examination-in-chief of friendly witnesses, sometimes by cross-examination of those who may be considered adverse. And thus, though a lawyer never knows anything himself, he is sometimes like the man in Shakspeare, who was said to be the cause of laughter in others; he may sometimes be the means of extracting information from other people. I have to apologise to the members of this Institution that, in consequence of the press of business, I have not been able to write what I have got to say; I must therefore ask them to make allowance for the imperfect manner in which I may make the observations which I have to offer. I hope they will accept whatever I shall say, in whatever form it is conveyed, not as didactic, but as interrogatory altogether. When speaking in the presence of persons of the greatest information, the remarks that I shall make, will be for the purpose of asking them to communicate to one another, and, through this Institution to the public, information upon matters in which the public is largely interested.

Now the question of the armaments of this country is, of course, in every point of view the most important question probably that the public has to consider. In the first place, upon the armaments of the country depend the honour and the safety of the empire. That is the first consideration. The second consideration is the question of economy in expenditure, which I put necessarily second to the first. With reference to that matter, allow me to say here that I think a great deal of misunderstanding has arisen upon this question. I know there have been persons, and I regret it more than anybody, who have used language with reference to the two great professions, —which, after all, are the pillars upon which the greatness of the English empire has been reared, and upon which it must always rest, —in a tone which I think everybody must condemn. The suggestion that there is any desire on the part of these professions to keep up armaments at a higher rate than is necessary, I believe to be entirely unfounded. On the other hand, that there should be any class of people who desire to see those armaments reduced below that point which is essential for the safety and the honour of the empire, I believe to be equally unfounded; therefore, the real question is, what is the nature and the extent of those armaments which are necessary and desirable for both those purposes? That is a question upon which I am here to-night to elicit information, if I can, from the scientific members of both professions. That every class of the community in this country will cheerfully bear the burdens which are necessary for the purpose of maintaining the armaments requisite for the maintenance of the honour and safety of this country, is a thing we cannot allow ourselves to doubt. For my part, all I can say is, as a member of another profession, my belief is that, in respect to the magnitude and laboriousness of the services they render, I believe there are no professions so inadequately remunerated as those of the Army and the Navy; but, as the Chairman has already pointed out, the subject before us is one into which no political considerations can enter, therefore I put that out of question altogether. Matters of public policy with reference to what may be considered the foreign policy of this empire, how far the Army and Navy may be required to exercise influence in European questions, that, no doubt, is a very interesting question, but one which would not be fitted to discuss here, and I put that out of the question altogether to-night. I do not ask what is the army or navy which would be necessary for England to carry on campaigns abroad, and to exercise influence in European affairs. Probably most people will agree that it is difficult, perhaps impossible, to maintain in this country an army which could cope with the armaments of the great military monarchies upon the continent of Europe. However, that also is a question which I do not raise here for a moment.

The question, then, to which I would ask your attention is that of the defence of the empire, and to that question alone. There is a question which necessarily occupies, and has very much agitated public attention—that is the question of the invasion of this country, in which I also include its colonies and its other dependencies. In many foreign countries, without doubt, matters affecting military and naval affairs are determined without any reference to public opinion, by a determination of the Governments which control the destinies of those countries; but in this country, our armaments and the defence of the empire must depend upon the conviction of the public opinion; and whereas public opinion can be rightly led or misled according to the information it receives, so it seems to me that an Institution of this character may be of the highest value in rightly informing public opinion upon questions of that nature.

Now there is one fact—and it is only facts that I wish to give, because opinions coming from me would be of no value—there is one fact to which I would venture to call your attention. There is no question that at this moment in this country we are maintaining a military land force as nearly as possible double that which previously to the Crimean war, and even during the period of the great European war, in the heat and fear of an invasion by the First Napoleon, we ever maintained. In round numbers we may say that the land forces of this country used to be 50,000, and in round numbers you may equally say that at this time they are 100,000 men. Now that is a fact which has to be explained; of course there is some reason for that fact or it would not exist. That requires to be explained, for I am sure the moment it is satisfactorily explained, no jealousy, no dislike of the burdens which must necessarily be imposed, would exist for a moment in this country. One of the first questions that I have to ask, and which I venture to think the ignorant public have a right to ask of the scientific members of the military profession, is why it has become necessary in the modern condition of things in Europe that the land forces maintained in this country should be double in number that which they were, say 20 years ago. If I might be allowed to suggest, it cannot depend upon the increased military forces of the continent, because the military forces of the continent have at all times, long before that period, been immensely greater than those of this country. There was no period at the beginning of this century, or at any time down to the year 1850, which is the period before the Crimean war, when the military monarchies of Europe had not three or four times as many troops as this country had. If you take Austria, France, Russia, or Prussia, at all those times they had a much larger number of men than ever we had.

Now, I suppose if you have got 50,000 men in this country, and another country has got 300,000, it signifies very little whether the other country has got 300,000 or whether it has got 1,000,000 of men, because the superiority of those forces is already so great that if it merely depended upon the number of the land forces, the doubling of a force which was already six times your own, really makes no difference. Therefore, the change cannot depend upon any mere increase of the land forces of continental powers. We must always have been at the mercy of the continent if it was necessary for us to maintain a land force equivalent to that of the military powers of the continent, because we never at any time had anything at all to compare with theirs. I think that at the time of the threatened invasion in 1805, just before Austerlitz, the regular land forces of England were 60,000 men, at the time when Napoleon had 300,000 or 400,000 men, with which he fought the great campaigns of Austerlitz and Vienna. Then it must depend upon something else. It depends upon this question surely, viz., how many men can be brought here; it does not depend upon how many men there are on the continent, because it signifies extremely little, if you have got a very narrow conduit pipe, whether you have got the Atlantic Ocean at the end of it, or whether you have got a washing tub, so it depends upon the strength of the tap and the smallness of the pipe, as to the number of people that may be poured into your shores, not upon the magnitude of the reservoir at the other end. Therefore, the question is how many men can be brought here; and the real question with reference to invasion is, I would venture to suggest—and here again I do it interrogatively altogether—has the power of bringing men to England increased in the last 20 years relatively to the power of resisting their power of coming here, or has it diminished? I venture to submit that that is the real question to be argued. It is immaterial whether there may be 1,000,000, or 10,000,000, or 100,000,000 of men ready to come from the continent, unless the means of transporting them to these shores has been increased in the meanwhile. Twenty or thirty years ago there is no doubt, there was always on the continent of Europe a far greater force that might have been brought, if it could have been brought, than there ever was in England to meet them. Therefore, the real question we have to discuss is, has the transporting power been increased by anything that has since happened, because unless the transporting power, or, as I venture to put it, the conduit pipe, which is to introduce the hostile element, has been enlarged, then the danger of the influx has not been increased?

There have been many popular publications which have agitated the public mind which seem to me to have altogether passed by this consideration, and have declined to discuss it. There is the well-known publication called "The Battle of Dorking." "The Battle of Dorking" assumes the passage. Well, that is begging the whole question, because if the passage is easy, and there is nothing to be done in passing the Channel, everybody knows that the military power of England is, and always has been, infinitely inferior to that of the great military monarchies. Therefore, if you choose to place England, by the assumptions of "The Battle of Dorking," as a continental power, with its confines approaching those of the great military powers, England has always been entirely defenceless. But I venture to think that that is not a way of treating the subject that will be satisfactory either to scientific members of the profession, or to the ordinary uninstructed public mind. The question is, what is the power which exists on the part of the great military monarchies of Europe of bringing their military power to bear upon the shores of this country? That is the question upon which, I would venture to suggest to this Institution the public mind would like to be enlightened. Before we begin to discuss what the North German army—for instance*—is going to do when it gets here, I would ask this Institution to tell us how it is to get here, because that seems to me to be the subject which has first to be settled.

As a person who has had to do with examinations, I know it is much easier to set questions than to answer them. I am going, with the leave of this Institution, to set a question which I should like to have answered. I will suppose a particular force to be available in this country. For the purpose of the problem, I will suppose that there is available in this country, capable, by railways and other resources we have, of being concentrated within a brief period upon a particular point, I will say 30,000 infantry of the line, behind that force a certain number of reserves, militia and volunteers, which you may put at any figure you like—you may put it at 30,000 or 50,000, or whatever figure you like. Then I will put in addition to that, what we may consider to exist in this country at this time, an available force of

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* The Prussian or North German army is mentioned throughout the argument only by way of illustration.—Ed.

10,000 cavalry. I believe the actual force of cavalry in this country is between 13,000 and 14,000 men, and about 8,000 horses, but this may be incorrect, therefore I think it would be fair to put the force of cavalry at 10,000 men. Then there would be 5,000 engineers, and what we have in this country at this moment are 56 batteries of field artillery—I would put it at 50 batteries of field artillery. That is what I assume to be the force with which you have to deal. You will remark that I have put the infantry of the line at one-half the actual existing force. I put it at 30,000 infantry of the line, 10,000 cavalry, 5,000 engineers, 50 batteries of field artillery. You might have 100 batteries of field artillery, because the number of artillerymen in this country is about 18,000. There are 15,000 foot artillery and 3,000 horse artillery, and I believe the number of men that go to a battery is 150 and 100 horses. Therefore you might, if you had the guns, easily have 100 batteries of field artillery, with the men for that number. Now I assume that as an hypothesis, and I ask what is the force which by any prudent military power would be provided to invade a country possessing such a force as that? I ask this Institution, and I venture to think the public have some right to ask the scientific members of an Institution like this for an answer to that question—what is the force which might be reasonably proposed to invade a country possessing such an army as that? Now I do not suppose that such a power would bring less infantry than 30,000 men if they knew there were 30,000 men here and irregular reserves behind them. They might pay us the compliment, as Napoleon Buonaparte did, of thinking it would not be worth while to invade England with less than 170,000 men. However, I will assume a country would not think of invading England with less than 30,000 infantry. I presume also, if we have 10,000 cavalry, they would not bring less than that; because if there is anything that we have learned from the Franco-Prussian war, it is, the great value of cavalry, especially with an invading army. Their foraging, their collecting materials of all kinds, horses, cattle, &c., must very much depend upon their having a superiority, or, at all events, an equality of cavalry, for I suppose a force of that kind would not move in the presence of a greatly superior force of cavalry which would clear the country before them, and in fact prevent their moving at all. Therefore I assume that they would not start with less than 10,000 cavalry, if we had got 10,000 cavalry here. Then as to artillery, we have 50 batteries, and I also venture to think that the enemy would not come with less field artillery than we possess at this moment, especially as I suppose we should have a very great power of establishing guns of position. I will assume that. Then the question that I have to propound to this Institution is, what is the amount of transport which is required to embark such a force as that? What vessels do you require to embark 30,000 infantry, 10,000 cavalry, 50 batteries of field artillery, and the camp followers and the non-combatants which are requisite for such a force? That is a question which I venture to think the scientific members of this Institution ought to give some answer to. It is a question capable of being solved I imagine, and it is one that we should like to have an answer to.

In an invasion—I think I am not wrong in saying—there are three matters to be considered: first of all the embarkation and the transport; secondly, the crossing; and thirdly, the disembarkation. I would like to ask an opinion upon these three points separately.

First of all as to the embarkation. What is the shipping necessary for such a force as that? You will see that what I have put, is practically an army of 50,000 men: 30,000 infantry, 10,000 cavalry, the engineers and 50 batteries of artillery, taking 150 men to a battery, would be about 10,000 more men. That is an army of 50,000 men. What is the shipping required to embark an army of 50,000 men, and where is it to come from?

In this country we are very little in the habit of appreciating the inferiority of other countries with respect to the mercantile marine. We are so in the habit of seeing in the ports of London, Liverpool, Glasgow, and Southampton, hundreds of great steamers going and coming, that we imagine that that is the condition of other nations. It is not so at all. If you examine the mercantile marine of great countries like France, Germany, Russia, you will find that they have not got any. Russia practically has got no ocean-going steamers at all. She has got a certain number of small coasting steamers of 200 or 300 tons burden. You will find that that is the case with Germany also. I find in the returns that the mercantile marine of North Germany is 48,000 men, which is about 12,000 less than the Royal Marine of this country. No doubt at Bremen, and places of that kind, they have a few large liners which go abroad; but if you come to examine the history of the mercantile marine of all nations except England, you will find it is practically insignificant.* Now I think that is a matter that is to be borne in mind. You will find in most cases where great military nations have had to undertake foreign expeditions like the French to the Crimea, they have had to put their soldiers on board their men-of-war. Why? Because they have nowhere else to put them. But a country that is going to invade a naval power cannot put its men on board men-of-war because the men-of-war will have to fight, and they will have to keep their men-of-war clear in order to fight. Therefore they must find their transport elsewhere. Then where are they going to find their transport? Happily the Neutrality Laws, which are becoming more and more understood, will prevent their hiring transport, because for a neutral Power to let transport to a Power at war, is an act of war. Therefore they can only get transport from their own resources or from their allies, because they cannot hire it from other countries. I wish again to ask the scientific members of the profession what is the number of vessels which would be required to embark this army of 50,000 men composed as I have suggested. It is to carry 30,000 infantry; that is not very difficult, because you may pack the infantry soldier in a small space; but you are going to carry 10,000 cavalry; you do not put those into a very limited number of vessels.

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* I have, since this paper was read, ascertained, by the kindness of the Consul of the North German Empire, the exact figures. They are as follows:—North German Lloyds, from Bremen, 20 large steamers; Hamburg line, 17 steamers; Baltic Lloyds, 3; total, 40. There are about 15 more in course of construction.

You are going to carry 300 guns; you do not put those into a very small space, nor the horses which are to draw them. You are going to carry a certain number of non-combatants, and that is a subject upon which I would ask the opinion of the Institution. What is the number of non-combatants which will accompany such an army as that? You are going to carry stores and provisions I presume, because the rashest Power in the world would not come to England without having a fortnight's provisions with him for men and horses; and you must have your ambulance corps and so on. Then, besides that, you must have your reserves which are to follow up and to supply your army, supposing it established and landed. What do you imagine would be the number of shipping that would suffice to carry such an army as that? That, I think, is a question which ought not to be left to speculation, but is capable of a solution.

The only facts that I can arrive at myself are those derived from recent experience. I will say nothing about Napoleon's great attempt, where he had nearly 2,000 vessels, because the conditions of the times are so different, that I do not think it is applicable. Now let us look at what happened in the Crimean expedition, and what were the figures. But, first of all, there are several matters to be considered. What is the time taken in making such preparations as these? because upon time depends notice, and upon notice depends the means you have of encountering attempts of this character. On the 20th August—I take this date from Mr. Kinglake's book—was taken the determination to sail from Varna to the Crimea. On the 24th August the embarkation commenced. On September 6th the flotilla sailed. Now that gives about a fortnight for the embarkation. I do not insist upon that because at Varna there were not the opportunities you might have in a country where there are docks, and where you might embark more rapidly than that; but I do call attention to this, that in a passage of about 300 miles, which is about the distance from the nearest point in Prussia (supposing we take Wilhelmshaven as the place from which an attack from Germany might come), the passage took eight days. People writing popularly on these subjects say, "300 miles! Oh, that "is 24 hours' sail." But that is not the way in which great armaments go. You might just as well calculate that because a man might walk 30 or 40 miles a day an army could do the same. That is not so, because, according to the experience, it was about 300 miles from Varna to the old fort, and from the time the flotilla sailed, to the time the landing commenced, was eight days, in perfectly calm weather, with no opposition, and under most favourable circumstances. How many days did it take to land the troops in the Crimea? The English had about 25,000 men; they had 1,000 cavalry, and they had 60 guns. It took them five days to land the troops. That gives one some notion of what is the nature of these operations. Mr. Kinglake, in his book, prides himself upon the extraordinary rapidity and activity with which the thing was done. He says, "In five October days 25,000 "men were landed." These are practical matters of experience; from the day when the embarkation commenced at Varna to the day when the battle of Alma was fought, which was two days after the landing was concluded, was exactly a month. Now that seems to me—unless there is some answer to it—to be a reply to the suggestion of *invasion by surprise.* And bear in mind this was an operation conducted by the three greatest maritime powers in the world, England, France, and, I believe you might say at that time, and even now, that the third great maritime power of the world was Turkey. At all events, you had a combination of those three Powers without any naval opposition whatever, who embarked an army of 60,000 men, and who embarked it so incompletely, that the French took no cavalry at all. They were not able to carry the horses for their guns: and being covered by the English Fleet, they carried their men on board their men-of-war, because they had no others. They got their transports towed by Turkish steamers. That was the condition of the maritime resources of France with reference to its power of carrying 25,000 men. England was in a different position. England had unlimited resources for transport. I would ask the attention of the Institution to the number of vessels which England employed upon that occasion. She kept her fleet for fighting and to cover the embarkation. How many vessels did it take for England to carry 25,000 men, 1,000 cavalry, and 60 guns, that is, 10 field batteries. Mr. Kinglake does not give the details of it in his book, but I find it stated in the "Annual Register" that there were* 400 transports. In Bazancourt's book, I find that the French took 25,000 infantry, 2,000 artillerymen, 800 engineers, 68 cannon. How did they carry them? They had 48 vessels of war, many of them three deckers, in which they packed their men; and they had 49 transports; that is, 97 vessels. The Turks had 7,000 infantry. They had 16 vessels of war towing 16 transports, making altogether 130 vessels. They carried no cavalry; they carried no land transport; they were not able to carry horses for their guns. Now, I do not suppose that is the way in which England is to be invaded. A military power would not come without cavalry, without land transport, and without horses for their guns. Then, where is the transport to come from? England, on the other hand, which did carry its equivalent forces, with 1,000 cavalry, had 400 transports. Now if the French Army and the Turks had been carried under similar circumstances, and if they had carried cavalry equivalent to the Army, and if they had carried horses for their guns, and if they had carried artillery, I do not think upon these figures that I have given you that it would be too much to say that, for that Army, it would have been necessary if it had to fight its way with its own fleet covering it, to have had 1,000 transports. I want to know where are 1,000 transports to be found in Europe, or in America, for that matter? Of course ships for transport may be constructed. But the construction of transports for an invasion is a matter of time; it is notice; it is a thing that people know about. But the thing we really ought to know is this—what is the amount of shipping that would be required? I have endeavoured to ascertain the number of horses to be carried in the expedition I have supposed, for they are the things about which there is real difficulty. There are, first of all, 10,000 cavalry horses. Take 50 batteries of artillery, which would be equivalent to the force we had in this country. On an average you may take 100 horses to a battery of artillery. that would be 5,000 horses more. How many more horses must be added for the land transport, the ambulance, and the general service of the army? Is it too much to say for an army of 50,000 men you must have 10,000 horses, or one horse to five men? If that is so, you have got to transport 25,000 horses, because I conceive an army invading this country must have the means of moving when it gets here, because I suppose our own cavalry would clear the country within ten miles of the landing, so that the army coming here would not be able to find transport on the spot. What is the shipping which is required to carry 25,000 horses? Now the only other document which I know of bearing on the subject—I believe it was not considered altogether a very economical and judicious arrangement—relates to the Abyssinian expedition. The facts of that expedition are to be found in the Report of the Committee of the House of Commons. There were 14,000 combatants sent to Abyssinia. The non-combatants who attended them were 50,000. I do not suppose that precedent would be pursued under the German organization. But that was the process in our campaign in Abyssinia. In order to attend upon the 14,000 combatants there were 50,000 non-combatants carried to Abyssinia. What were the number of beasts of burden of various kinds, horses, mules, donkeys, camels required, in order to put 15,000 combatants in marching order in Abyssinia? There were 35,000, exclusive of four elephants, that is to say, three beasts of burden to every man. For an army of 50,000 men, if that were so, it would be 150,000 horses. But I do not assume that. I put it at a very low figure. I assume that the German Army might be content with 25,000 horses as against the 35,000 animals that we employed in Abyssinia for 15,000 men. What was the amount of transport we employed there? There were 302,000 tons of transport employed in carrying the expedition. If you examine the list of transports you will find page after page of the Parliamentary Report filled with lists of vessels of 1,000, 2,000, and even 3,000 tons, amounting to several hundreds in number, that were employed for the purpose of putting that army ashore. It requires very little knowledge of the history of the world to know that no country could have done it except England. It is not to be done anywhere else; the vessels do not exist. Therefore, I want upon this first branch of the question, a scientific answer from this Institution as to what number of steam-ships (of a thousand tons burthen we will say), it would require to carry such an army as I have described, with its cavalry, its guns, its stores, and its camp followers? That, I think, is a question we may fairly submit to your consideration, and require an answer to it.

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* This figure is inaccurate. It will be seen that it was corrected at a later stage of the discussion.

Now, I come to the second stage of the question. Assuming that you have got that amount of transport, that you have got it in a safe harbour where you can embark with ease, that you have got your troops on board, how are you going to get across? That depends of course upon your own naval force and the naval force that you have to oppose, and upon that subject I would again venture to ask the opinion of this Institution what the first process would be; because these things are not done in a corner. You do not collect a flotilla of transports in a harbour in Europe without somebody suspecting that something is going to be done; you do not put an army of 50,000 men, with 10,000 cavalry and 300 guns, on board, just in the same way that you go down by the night train and cross from Dover, though I know that is the popular idea. These are things which take some time, which attract some attention, and you have an idea that something is about to occur. I imagine, then, that if you have got a fleet at all you would blockade the harbour where these transports are collected, and would watch what is going to occur when they come out. In old times a blockade with sailing vessels was carried on at a distance. Nelson blockaded Toulon from Sardinia; and in such circumstances it was possible for a fleet to sail out and nobody to know anything about it. But we know since the American civil war, that you may maintain an absolute blockade not only in summer but in winter, as the blockade of Charleston, Wilmington, and other places was maintained by steam, in a manner in which a blockade was never maintained before. Nay, more than that. I venture to think that with the present appliances of swift vessels and telegraphs, you might know in a very short time what was happening in the North Sea at any moment. I do not see why you could not have the "Great Eastern" anchored off the harbour in constant communication with the War Office in London, with the present means of ocean telegraphy which we possess. At all events, you might have rapid communication; and if you have a superior fleet and an effective blockade, a flotilla of that character could not leave the harbour unless it had a fleet prepared to fight a general action and beat the blockading squadron, otherwise it would not signify whether they had got a million of men or ten millions of men on board; unless they could command the sea by beating the fleet outside they would not have a chance of success. I was looking the other day at a paper, which has recently attracted the attention of this Institution, by Captain Tulloch, and I saw a sentiment, which coincides with my own, in a paper that he read on "the defence of London." He said in answer to Captain Hoseason, "To answer your question first, I may say that I "start with the assumption that the enemy would have the command "of the sea, because to suppose that he would attempt an invasion as "long as the English Fleet was on the water is out of the question." I venture to think that that has been the assumption of every military man from time out of mind. It certainly was the assumption of Napoleon; it has been the assumption of every man who has dealt with this question hitherto. Therefore the question is, what probability or possibility is there that any European Power, or any combination of European Powers, can command the sea, either temporarily or permanently, in the existing state of the establishments of this country?

Now this is the only point upon which I can hope to supply any information to the Institution which may be considered of any value; viz., the actually existing state of the English Navy and that of the navies of Europe. In the year 1870 the ships completed and building —I am speaking now of ironclads alone, which for fighting purposes are really the only ones worth considering—were forty-seven vessels. Of these the "Captain" was lost, and the "Prince Consort" is a vessel just condemned, leaving forty-five. There have been built and completed since, four. There is one which has just been commenced since; however, I do not count that, because that is not completed. That leaves forty-nine completed ironclads in England which are more or less effective. The country against which we have always been building, and with which we are apt to compare, is France. In 1870 it was estimated that the French had fifty-two ironclads, but of these eight have, since that time, been condemned as worthless. That leaves forty-four; but of these fifty-two, ten, which were commenced, have not been completed and are in a very imperfect condition of completion. Now that leaves, as against the English forty-nine iron-clads, thirty-four French ironclads.

English Navy at commencement of year 1870.

Ships completed and building	47
Lost ("Captain")	1
Condemned ("Prince Consort")	1
	45
Built and completed since—	
"Hecate" "Gorgon" "Hydra" "Cyclops"	4
Commenced since ("Fury")	1
	50
All completed save "Fury"	1
Total completed, May, 1872	49

French Navy at commencement of 1870.

Ships completed and building			51
Commenced since 1870 (" Triomphante ")			1
			52
Of these, *condemned*—			
3 Ironclads	" Gloire " " Normandie " " Invincible "		
4 Ironclad floating batteries.	" Paixhans " " Palestre " " Peiho " " Saigon "		8
1 Ram	" Rochambeau "		
			44
Of these, *not completed*—		Amount done.	
5 1st class Ironclads	" Colbert "	$\frac{4}{100}$	
	" Trident "	$\frac{10}{100}$	
	" Friedland "	$\frac{72}{100}$	
	" Suffren "	$\frac{60}{100}$	
	" Richelieu "	$\frac{30}{100}$	10
3 Ironclad corvettes	" La Galissonière "		
	" Victorieuse "	$\frac{10}{100}$	
	" Triomphante "	$\frac{14}{100}$	
2 Rams	" Belier "	$\frac{84}{100}$	
	" Tigre "	$\frac{68}{100}$	
Total completed, May, 1872			34

Now, I have got here before me a paper drawn up upon very authentic information. Of course this is a subject of which I know nothing myself, but I can give it upon authority, upon which I can entirely rely; it is an attempt to pair off the French Navy against equivalent ships in the English Navy. See what you have left after you have done that. It is a difficult thing, of course, to make this comparison, because there are three elements to be considered. There is first, the thickness of armour-plating when you are comparing equivalent vessels; then there is the weight of the guns; and then there is the speed of the vessels. Of course the comparison must vary according to these elements. But I would make this observation; it is known that there are a certain number of vessels which are considered obsolete in England; but then it must be considered that there are an equal number of vessels which are considered obsolete in France. We must pair off the obsolete vessels of one country against the obsolete vessels of the other. When you are dealing with the weight of guns, if you have got 6½-ton guns which will penetrate the armour of another vessel, it signifies very little that that vessel should have heavier guns, because if the guns of each vessel will penetrate the armour of the other, the advantage, I am told, remains with the number of guns. Just as it would be with wooden vessels, if you had guns that equally penetrated, then the superiority would remain with the vessel which had the greater number of guns. To gentlemen who know a greatdeal more about it than I do, I would just read this list, and the pairing which is suggested as between the English and French vessels.

SHIPS.

	English.	No. of each class.
Ironclads (completed) sea-going.	"Hercules" "Sultan"	2
	"Bellerophon" "Lord Warden" "Lord Clyde" "Agincourt" "Minotaur" "Northumberland" "Repulse" "Royal Alfred" "Penelope"	9
	"Achilles"	1
	"Caledonia" "Royal Oak"	2
	"Resistance"	1
	"Ocean" "Zealous" "Hector" "Valiant" "Defence" "Pallas" "Favourite"	7
Rams and Turret-ships.	"Hotspur" "Rupert"	2
	"Viper" "Vixen" "Waterwitch" "Enterprise" "Research"	5
	"Royal Sovereign" "Prince Albert"	2
		31
Ships remaining over.	"Monarch" "Devastation" "Thunderer"	3
	"Audacious" "Invincible" "Iron Duke" "Vanguard" "Swiftsure" "Triumph"	6
	"Warrior" "Black Prince"	2
	"Hecate" "Gorgon" "Hydra" "Cyclops"	4
	"Glatton" "Scorpion" "Wyvern"	3
Grand Total		49

	French.	No. of each class.
	"Ocean" "Marengo"	2
	"Flandres" "Gauloise" "Guyenne" "Heroine" "Magnanime" "Provence" "Revanche" "Savoie" "Surveillante" "Valeureuse"	10
	"Belliqueuse"	1
	"Magenta" "Solferino"	2
	"Couronne"	1
	"Alma" "Armide" "Atalante" "Montcalm" "Jeanne d'Arc" "Thétis" "Reine Blanche"	7
	"Taureau" "Cerbère" "Boule Dogue"	3
	"Onondaga"	1
Seven floating batteries.	"Embuscade" "Imprenable" "Protectrice" "Refuge" "Opiniâtre" "Arrogante" "Implacable"	7
		34

Of course I give this upon no authority of my own, but upon authority upon which I can rely. I am told that those thirty-one English ironclads, regarding the elements to which I have referred, may be fairly compared with the thirty-four French vessels that I have named.

Now, what remains after that? You have paired off against the great naval Power of the world, and you have remaining nineteen English ironclads of the first class, after you have disposed of the French Navy by an equal force.

Now, what is the condition of the other navies of Europe?

First of all, let us take Prussia, as a country from which invasion is considered formidable. Prussia has three ironclads, none of which she has been able to build herself. Two have been built in England, and one in France. I believe she is now attempting to build an ironclad. That is the country by which a nation with forty-nine ironclads is about to be invaded! What I want to ask this Institution is, why is it more probable that a country, removed by 300 miles of sea, with fifty ironclads, is going to be invaded by a country with three ironclads, than that England with 5,000 men is going to march to Berlin over the Prussian army? I cannot understand why the same process of reasoning that is applied to a military force is not to be applied to a naval force. If you have an army of 5,000 men to attack an army of 500,000 men, you hardly think the matter worth discussing. Then is it worth discussing the invasion of a country which has fifty ironclads by a country which has three ironclads? That is a question I venture to put to a scientific Institution. It is a question that may be susceptible of a scientific answer; but to an ordinary mind it appears to be as great a delusion as it would be to march to Berlin with an English Militia regiment, which at present we do not consider to be an easy performance.

There is another country which might be combined with Prussia, which it is also worth considering, and that is Russia.

What is the condition of the Navy of Russia? Russia has two ironclads, of which the plating is 4½-inch armour, and which are described as being of the same style as the "Warrior," but inferior. The "Warrior" is considered to be one of our most inferior ironclads at this moment; and the best of the ironclads of Russia are inferior to the "Warrior" with her 4½-inch armour. Then there are three ironclads which are described as of the same style as the "Defence," but inferior to that. That is the naval force of Russia. Now, if you put Russia and Prussia together, you will find that they have seven ironclads. The Prussian ironclads, I believe, are very good ones, and the Russian extremely bad ones. They have a number of monitors besides, which are meant for coast defence. They are building also, I ought to mention, two large vessels of the "Devastation" class. If you put Russia and Prussia together, they have what you may call seven moderate ironclads among them, as against nineteen ironclads of England of the first class, after disposing of the French Navy.

Then, if you like to add to these two countries the United States, which possesses no ironclad that is capable with safety unaccompanied by a consort, of crossing the Atlantic, you have a combination of Powers with which you may have to deal.

We have heard it said that we should always be prepared for all emergencies. Now, I propose that we should deal with this combination of circumstances—that we should have war made upon us at once by France, Russia, Prussia, and the United States. If you can conceive all these countries combined, you will find that after putting ship for ship against theirs, it would leave ten ironclads of the first order to spare as against them. Now, what I have to ask of this Institution as a scientific body is, to describe what is the process by which, in the presence of a fleet of that description, a flotilla of a thousand transports is going to put to sea, and how is it going to be dealt with in the presence of a fleet of that description? It is said that fleets are decoyed away. It is not easy to decoy away an ironclad; it is rather too heavy a burden to be decoyed easily. All our ironclads are at home or in the Mediterranean, with three exceptions—one in a distant part of the world, and two elsewhere. That is the existing condition of things. You say that might be altered. It may be altered. Russia and Prussia may build more vessels. They have never been able to build one yet, although I believe they are trying to do so. Where are the dockyards of Prussia—dockyards which correspond to Chatham, Portsmouth, Plymouth, Pembroke? And, after that, where are the dockyards to correspond to the great private dockyards on the Clyde and the Mersey, of Messrs. Laird and other great contractors? If Prussia began to construct, we could build ten vessels to one she could build, as soon as we knew what she was doing. Where is Russia going to construct against us? Where is the United States going to construct against us? I heard the other day from a relative of mine, who belongs to the naval profession, that a distinguished American Admiral, looking at the "Monarch," said to him, "Not only have we not got such "a vessel in our Navy, but in our country we cannot construct such "a vessel, because we have not the artificers; and with the difficulties "in the way of using iron which the state of the laws in America has "introduced, the difficulties of construction are ten times as great in "our country as they are in yours." And when I speak of the present condition of things, I would also point out with reference to the future, that the powers of England in construction, if we should ever feel ourselves called upon, are infinitely greater than those of any other country in the world.

What, then, is to be the process of this flotilla coming to us? It really seems almost an absurdity to consider the question of a fleet putting out from Prussia with its three ironclads, assisted possibly by Russia with four more, because, with the forty or fifty ironclads of England, they could not show their noses out of harbour. But supposing them assisted by a fleet at all equivalent, and assume them to get away for a moment, we may suppose that we should have some ships left at home. I have put before you these figures with reference to the Navy of England and the Navies of the world, and I think if they can, as I believe they can, be implicitly relied upon, there is this fact, that the fighting Navy of England is equal or superior to all the fighting navies of the world put together. I am not counting odd ships, that you may find in Spain or Italy; because no man makes the assumption that all the countries of the world would ever combine together against one country. If that were so, no military nation would be able to maintain its independence, because no one single nation would be able for any length of time to resist a combination of all the other Powers on the Continent. No one assumes that there is likely to be any such combination of Powers against North Germany, if you did, even her present army would be wholly insufficient. When you join together Russia, Prussia, France, the United States, I think I have made an assumption as large as it is necessary under the circumstances. If after that I have shown you that we have got a residuum of ten powerful ironclads, ship for ship, I think I have so far established my proposition. Now, if you were playing the Prussian "war-game," as the Prussians play it upon land and as you may play it on the sea, and you were to put down the representative pieces to represent the naval powers of England and the naval powers of other countries, do you think they would think it worth while to throw the dice in order to calculate the chances of an expedition of this kind starting? That is again a question I venture to suggest.

Now I come to the third and last stage, that is, assuming all these difficulties got rid of—because the difficulties are a compound of simple difficulties, and they range in a sort of geometrical proportion—supposing the Prussians have got rid of our enormous superiority of fleet, what are they going to do? That again is a question upon which we should like to have some information, what is the process of disembarking a force against an enemy on shore ready to receive it? I assume this thing is not done in an instant. It takes days to prepare the expedition; it takes some time to fight this general action in which five ironclads will destroy fifty. We have made that assumption, that five German ironclads have destroyed fifty English ironclads and sent them to the bottom. The English Navy has been beaten by one vessel to ten, and it does not exist any more. Then, the expedition is ready. What is it going to do when it gets to shore? In the old days, and in the letter of the Duke of Wellington, the danger that was contemplated was that an expedition might take possession of some small estuary or harbour and would have days there to land. Speaking ignorantly on that matter, I am informed that the question of torpedoes has very much settled that, and that you can protect estuaries very well by torpedoes from the invasion of vessels in that way; therefore an expedition is more than ever reduced to the necessity of landing troops on an open beach. What is the process of landing from a flotilla of transports upon an open beach in the presence of the force that I have supposed of 80,000 infantry, 10,000 cavalry, and 50 batteries of field artillery? I should like to hear exactly from scientific men how the thing is to be done. Now, though you have sunk the British fifty ironclads by four or five Prussian ironclads, there is something left. There is a force of English gunboats, of the class of the "Staunch," which carry 18-ton guns, that can penetrate the armour of almost all the vessels in Europe. They draw six feet of water, and you may have as many of them as you like made in three months. What would be the result of 100 of these vessels carrying 18-ton guns running a-muck among a thousand transports? I have been told by people present in the Crimea, that very few vessels making the attempt would have disorganised our landing. After all, besides the ironclad fleet of England we have many hundreds of unarmoured vessels which would be perfectly competent to attempt to disorganize the landing. Then with reference to the landing itself. I suppose the guns of the five victorious Prussian ironclads would cover the landing. Then, what I would like to ask is this, if the guns of the ships can cover the landing, why should not the guns on shore in the same way prevent the landing? If it is easy to fire two miles from sea on to an open beach, why is in not just as easy to fire two miles in-shore upon an open beach? The thing I would like to ask, as an ignoramus, is, what becomes of the first 10,000 men that are landed? You cannot land everybody at once; you cannot land all the horses at once. We know in the Crimea it took five days to land the English forces; but in the course of those five days, or three days, or four days, what would the British troops be doing? I want to know exactly what is done with an expedition of 50,000 men, supposing a hostile force is concentrated by railways to meet it, with an unlimited supply of engineers, guns of position, naval artillery, and other resources of defence; what, in the first three days, do you think would become of the first 10,000 men who are landing in boats upon an open beach? It is always assumed that they are very comfortable during that period. I would venture to ask, in the presence of the united profession, whether there are not some means known to the military arts by which it would be possible to make the first 5,000 men that land very uncomfortable. Unless there are, it seems to me that the profession has not reached its perfection yet. We know in the Crimea, for some reason or other, the landing was perfectly undisturbed. That is a very agreeable thing. But we imagine that in this country we should not make it so agreeable to the force which arrived, and that there would be some attempt to deal with them when they came; that if it takes five days to land 50,000 men before those 50,000 men did land, something would be done with them at all events. How are they going to move when they get here? Presuming that they arrived by land, of course the thing is totally different; but by sea, supposing our 10,000 cavalry have come down upon the beach, and with the help of the rural police have removed the horses and the cows and the sheep and pigs from ten miles within that landing, they would find themselves in a desolate condition, and they must rely upon what they have got with them both to feed themselves and to move themselves.

I have always heard—I know nothing about military affairs—that one of the essential things in war is to have a base, and that you must keep your communications open. What is the base, and what are the communications of an army coming by sea? I suppose it is the permanent command of the sea. Now, unless the invading army has not merely a temporary command of the sea, but unless it has a permanent command of the sea, its communications are gone; and it would be just in the same situation that the Prussian Army before Paris would have been if the Franc-tireurs had been able to cut the line between Metz and Paris. Therefore, what an enemy must have, is not merely temporary command for a few days, or a few weeks, but a permanent command, which shall keep up his communications, or else his base is cut off absolutely and entirely; and that I have always understood is a serious matter in war.

Now I have to apologise to the Institution for having detained you so long. If in a great deal I have said I have displayed ignorance, I am perfectly ready to confess it. But I have laid these matters before you for the purpose of asking you to enlighten us, who know nothing about these things, suggesting to you the difficulties which do occur to unpractised minds on these matters, and to ask for answers to these things. If it be true that in the presence of a superior naval force invasion is impossible, surely the answer to that is, if that naval force is not overwhelmingly superior, make it so. Because unquestionably you can make your naval force overwhelmingly superior in a country like this of steam, of iron, and of seamen, much more easily than you can make your military force overwhelmingly superior. Therefore, if your force is not, upon the figures I have shown you, overwhelmingly superior, let it be made so. If fifty ironclads are not enough to fight five Prussian ironclads, let us have a hundred English ironclads to fight five Prussian ironclads, and let us feel safe if we can. If it requires a hundred English seamen to fight one North German seaman, let us retain their services, and let us be safe. Let us make up our minds as to how many English ironclads it is necessary to have in order to fight a Prussian ironclad, or a Russian ironclad, or a United States' ironclad; then let us have them, and let us be safe.

I feel how much I have to thank you for your indulgence. I have only to say, in conclusion, that the only value of this paper will be found in the discussion which I hope it may elicit.

APPENDIX.

English Armaments.—*Individual Ships.*

Name of Ship.	Number of ton guns.						No. of guns.
	35	25	18	12½	9	6½	Total.
“Sultan”	..	..	8	4	..	..	12
“Hercules”	..	..	8	1	..	4	13
“Bellerophon”	..	..	..	10	..	2	12
“Lord Clyde”	..	..	..	2	14	2	18
“Lord Warden”	..	..	..	2	14	2	18
“Agincourt”	..	..	..	6	..	22	28
“Northumberland”	..	..	..	4	22	2	28
“Minotaur”	..	..	..	4	..	22	26
“Repulse”	..	..	..	..	12	..	12
“Royal Alfred”	..	..	..	10	..	8	18
“Penelope”	..	..	..	..	8	..	8
“Achilles”	..	..	..	..	4	22	26
“Caledonia”	..	..	..	..	4	20	24
“Royal Oak”	..	..	..	..	4	20	24
“Resistance”	..	..	..	..	2	14	16
“Ocean”	..	..	..	..	4	20	24
“Zealous”	..	..	..	..	..	20	20
“Hector”	..	..	..	..	2	16	18
“Valiant”	..	..	..	..	2	16	18
“Defence”	..	..	..	..	2	14	16
“Favorite”	..	..	..	..	..	8	8
“Pallas”	..	..	..	..	4	..	4
“Hotspur”	..	1	..	..	..	..	1
“Rupert”	..	..	2	..	..	..	2
“Viper”	..	..	..	..	..	2	2
“Vixen”	..	..	..	..	..	2	2
“Waterwitch”	..	..	..	..	..	2	2
“Enterprise”	..	..	..	..	..	4	4
“Research”	..	..	..	..	..	4	4
“Royal Sovereign”	..	..	..	5	..	..	5
“Prince Albert”	..	..	..	4	..	..	4
Total	..	1	18	52	98	248	417
Armament of remaining English Ships.							
“Monarch”	..	4	..	..	..	..	4
“Audacious,” and five sister ships	..	..	..	10 50	..	.. ..	60
“Glatton”	..	2	..	..	..	..	2
“Hecate”	..	..	4	..	..	..	4
“Hydra”	..	..	4	..	..	..	4
“Cyclops”	..	..	4	..	..	..	4
“Gorgon”	..	..	4	..	..	..	4
“Warrior”	..	..	..	..	4	28	32
“Black Prince”	..	..	..	..	4	24	28
“Scorpion”	..	..	..	4	..	..	4
“Wyvern”	..	..	..	4	..	..	4
“Devastation”	4	..	..	..	..	..	4
“Thunderer”	4	..	..	..	..	..	4
Total	8	6	16	68	8	52	158

FRENCH ARMAMENT.—*Individual Ships.*

Name of Ship.	Number of ton guns.				No. of guns. Total.
	22	14	8	4½	
"Ocèan"	4	4	..	..	8
"Marengo"	4	4	..	..	8
"Flandres"	..	8	4	..	12
Nine sister ships	..	72	36	..	108
"Belliqueuse"	..	..	4	6	10
"Magenta"	..	10	4	..	14
"Solferino"	..	10	4	..	14
"Couronne"	..	6	2	..	8
"Alma"	..	..	6	..	6
Six sister ships	..	..	36	..	36
"Taureau"	..	1	..	..	1
"Cerbère"	..	2	..	..	2
"Boule Dogue"	..	2	..	..	2
"Onondaga" (not armed)	..	..	..	..	..
Seven floating batteries	..	..	28	..	28
Total	8	119	124	6	257

PRUSSIAN IRONCLADS.

Names.	Tons.	Guns.	Horse-power.
"King William"	5,938	23	1,150
"Frederick Charles"	3,800	20	950
"Crown Prince"	3.404	16	800
"Prince Adalbert"	779	4	300
"Arminius"	1,230	4	300

Two 1st class frigates, 3 turret ships, and 1 sloop are building.

RUSSIAN NAVY.

"Sevastopol" "Petropaulouski"	Same style as "Warrior," but inferior. 4½ inch plates.
"Pervenety" "Petron Menia" "Kremlin"	Same style as "Defence," but inferior. 4½ inch plates.
"Knaz Pojarski"	A large "Pallas." Very crank. 4½ inch plates.
"Admiral Lazaref" "Admiral Grey" "Admiral Spindoff" "Admiral Chichagoff"	Turret ships, without masts or hurricane decks. May be classed as "Prince Alberts."
"Alexander Neffsky" "General-Admiral" "Minia" "Cruiser"	Building.

COMPARATIVE ARMAMENTS ENGLISH AND FRENCH.

English. *French.*

Name of Class of Ship.	25-ton gun.	18-ton guns.	12½-ton guns.	9-ton guns.	6½-ton guns.	Total number.	Name of Class of Ship.	22-ton guns.	14-ton guns.	8-ton guns.	4½-ton guns.	Total No. of guns.
"Hercules" "Sultan"	..	16	6	..	4	26	"Ocèan" "Marengo"	8	8	..	..	16
"Bellerophon" "Lord Warden" "Lord Clyde" "Agincourt" "Minotaur" "Northumberland" "Repulse" "Royal Alfred" "Penelope"	..	..	38	70	63	171	"Flandres," and nine sister ships........	..	80	40	..	120
"Achilles"...........	..	..	..	4	22	26	"Belliqueuse"	..	..	4	6	10
"Caledonia" "Royal Oak"	..	..	..	8	40	48	"Magenta" "Solferino"	..	20	8	..	28
"Resistance".........	..	..	..	2	14	16	"Couronne"	..	6	2	..	8
"Ocean" "Zealous" "Hector" "Valiant" "Defence" "Pallas" "Favorite"	..	..	..	14	94	108	"Alma," and six sister ships ..	..	..	42	..	42
"Hotspur" "Rupert"	1	2	..	..	..	3						
"Viper" "Vixen" "Waterwitch" "Enterprise" "Research"	..	..	..	..	14	14	"Taureau" "Cerbère" "Boule Dogue"	..	5	..	..	5
							"Onondaga"	..	..	..	..	(unarmed)
							Seven floating batteries	..	..	28	..	28
"Royal Sovereign" "Prince Albert"	..	..	9	..	..	9						
Total English armament in number of guns	1	18	53	98	251	421	Total French armament in number of guns	8	119	124	6	257

Colonel Sir SHAFTO ADAIR, Bart.: I am sure, Sir, I cannot better preface the few words I shall have to offer on this occasion than by expressing what we must all feel, viz., thanks to our visitor for the opportunity he has given us of expressing our opinions on a subject of so much importance, and especially on this ground, that, prominent member as he is of the House of Commons, he will have the opportunity of informing his colleagues of what he has heard from the Officers of the profession on points of so much importance, and which in that assembly are not always as well understood as they deserve to be. With regard to the questions the honourable gentleman has put, I confess I should have great diffidence, although it is a subject that has occupied my mind for a great many years, in speaking at any length, were it not that we have already on record answers to some questions that he has put, in the department to which I shall particularly apply myself. I do not presume that I could give the answers which the honourable gentleman has requested on professional points. That would be far from me. On the general subject I will venture to make a few remarks, and endeavour to answer his questions. First of all I understood him to inquire whether the proportion between the military force of England and the military forces of other great monarchies, was so changed as to require a larger development of military power on our part than was ever necessary before. I answer in this way. It is true the preponderance was even greater formerly than it is now, but then Europe was in a state of very different public feeling, and under very different maxims of government, and appliances of mechanical force, from those under which she exists at present. I have no wish, and it would be highly irregular if I were to introduce any matter trenching on the policy of the subject as regards our relations to the Continent, and from that the honorable gentleman has very properly and judiciously warned us; but we see that whereas armies formerly were levied for the purposes of war, now whole nations are on foot; we see that it is considered in the ordinary practice of policy to imitate and to work out such principles and actions of government as is fast re-casting the whole system of the European aggregation of States. I see the military spirit dwelt upon as a civic duty. I say then, that the difference is between England as with her increased force, and her, so to speak, volunteer soldiers, and the nations of the Continent, who are now bringing every man into the ranks. As I understand, the question is, whether this could take place by surprise, whether such combinations could be made as would throw large forces against us without our having previous knowledge. Now Governments change, systems of policy are varying from time to time, and at present are very much affected by the personal characters of those who govern, and I can conceive a state of things in which a large combination, even more formidable than that the honourable gentleman has referred to, and one supplying means of transport and maritime power even more largely than he has assumed, being perfectly possible, and under certain impulses directed against our commerce and against our interests, and as a means of affecting them, against our shores. We will suppose, and we have a right to suppose, that in the great confusion that is taking place, there may be a further aggregation to the westward, and I know that that is an apprehension entertained on the Continent. I can conceive of a state of things in which channels of debouch, so to speak, against our shores, would be in the possession of an unfriendly power north of Dunkirk, and to the west of Holstein, and I know that that is an apprehension entertained in a portion of Western Europe. Then, Sir, we come to the consideration, supposing such a combination possible, of the means of transport, and the direction those forces would take. If I may be permitted to say with great deference, I apprehend the honourable gentleman has not thoroughly considered the circumstances which would probably accompany any demonstration of armed force against this country. There probably would not only be one or two great expeditions which are to endeavour to land their troops upon a particular point, but there would be subsidiary expeditions. Here I come to a fact, and for our better knowledge of this subject it will be remembered that Carnot, when he presided over the War Department under the Directory, and was carrying on that magnificent campaign in Flanders, had prepared a scheme for the invasion of the British Islands at three points, of which one expedition was to land in Ireland, another expedition to land in Sussex, and another to land in Yorkshire. I believe the expeditionary forces would be sub-divided, in order to distract attention, and to withdraw the ironclads (on which to a certain extent I perfectly go with the honorable gentleman, as to the application of the force), from what I may call their line of battle. Supposing that to be the case, we come to the ponderation of force, and here I am sure I carry all Officers with me in saying that in military matters the operation of genius comes in after the machine is perfectly prepared; that the foundation of military power afloat or ashore is that which is prepared long before, and consolidated, tried, proved, and purified. Sadowa was the result of the battle of Jena; Sedan was the result of the battle of Sadowa. From one point of failure to one point of success, and from that point of success to a still higher point of success, the Prussians marched with a determination which carried them over three-quarters of a century in preparing to place their King on the throne of United Germany. Fortunately, as I have said, the means of applying a test to the questions of the honourable gentleman already exist. First of all, I cannot but think that what I call the transport of Europe is rather underrated. I turn to the account of the expedition to Civita Vecchia, and I turn to the account of the expedition to Algiers. I find as well as I can remember that the expedition to Civita Vecchia was prepared in three days and transported in ten; and the expedition to Algiers was embarked in three days and transported in fourteen, by 110 vessels of war, of which only 7 were under steam, and 602 transports of all classes. There stands the fact, whatever it may be worth. Now with regard to the amount of transport required, I have been at some pains to draw out a proportionate scale of the transports required for the expedition to the Crimea, and I find our forces were on the whole—our infantry, artillery, horses, guns, and stores, conveyed in one steamer, and two transports to each 1,000 men. This, be it correct or not, gives a datum from which we may calculate. Well, then, there is another point, and old Officers will be carried back in their professional recollections, and will remember that about 18 years ago there was a famous project of invasion, published by Baron Maurice, a French Officer, and translated and commented upon with great clearness and lucidity by the then Captain Addison. He remarks on the difference that steam has produced as a means of carrying on war, and whereas Napoleon the Great was restricted to one harbour, he forms his supposition under the idea that three harbours would be selected, from which three armies would invade England, the Army of Brest, the Army of Cherbourg, and the Army of Dunkirk, and he comes to England, and it ends by his placing 237,750 French soldiers in line, the purpose of the invasion being accomplished. Then comes the question, what force we have to meet them. I am now speaking of calculations, and I must refer to a work found in the pages of the "Journal," and I take a calculation which in some measure accords very nearly with that of the honourable gentleman. I take the 110,000 militia, who, I venture to think, when drilled and trained, as we have seen, will do their work well on their own soil; I take 40,000 infantry, and I find it is perfectly possible by distribution before hand, by arrangement—and that was the plan I suggested at the time of breaking up the Militia into infantry brigades, and distributing them in different parts of the country—with the assistance of the cavalry, who, I venture also to bring into line, the yeomanry cavalry, together with 14,000 or 15,000 of the regular cavalry, with the field batteries we possess, and with the militia artillery, for the purpose of fighting battles of position, I find it is perfectly possible to hold our own with what I call the statutory power within this island, and to increase it, as of course we may, to any extent. The statutory power is that which is given by statute of raising so many men during the prospect of war and invasion, without counting the masses of volunteers, and to them I attach great importance in this way. I remember a story of the French General, well known in the African war, General Changarnier. He had large masses of Zouaves, and on one occasion, his guns not being up, to clear one of the defiles held by the Arabs, he asked for his "artillery"—his Zouaves—and had it up. He said "jette la lance," threw them against the forts, and carried them by escalade. In that manner, as well as in line, the Volunteer forces of our country would be available, and therefore this brings me to the point that I object to saying that our force is too great for our requirements within our own shores. With regard to Scotland, and with regard to Ireland, the defensive nature of the country can be easily ascertained by Officers. Most of us are acquainted with it, and how well the country may be defended, that is, with regard to the actual available power. Then, it is asked why we, though being a power strong in "iron-"clads," and having to contend with smaller masses, should anticipate invasion. It must not be forgotten that England is not only fighting for herself, but she is fighting for her colonies; she is fighting for her commerce; she is fighting, I dare declare it here, for the cause of reasonable order throughout the world. I am not one who would launch this country on a Quixotic course of conquest. The days of our conquests by military force are over, but the days of our protecting the countries we have gained and our Colonies by military force, are not yet past, and I trust they never will pass away. Then, Sir, with regard to the information we may obtain, who believes in information in these matters until the fact is at their door, if there is any reason to divest their mind of it? The trader goes to his ledger, and he says, "This is my business now the 'Alabama' affair is over; we shall hear no more "about it." Every man goes to his profession, and that is the happiness of England, that every man has his special duty, which occupies his mind when he is not called upon specially to the service of his country. But we must be cautious that the great fabric which we have built up with so much care, and which, after all, though of stout materials, has sometimes rested on a fragile base, is not shaken down by our supineness. It is not that we may be called upon to put out our gigantic strength, but it is that if the belief once becomes thorough, that we hesitate to put out this force, a scene of confusion and distrust would arise amongst our industrial population, and all the dwellers in this country would have a right to complain that the Government was unequal to and had neglected its duties. I will give a case in point in this matter to show the sensitiveness of commerce. I was lately in the north of Ireland, near Belfast, and then to repeat the subject of a lecture which I gave here by permission of the Council some six weeks since.* I was dwelling on the defensive character of Ireland, and I say this by the way, when you hear of invasions by traitors from abroad, or sympathisers from the other side of the Atlantic, you may set those rumours at defiance, and hold them very cheaply. Ireland is perfectly able to defend herself, with the assistance of her loyal subjects, and such troops as the Queen can spare, against the strongest force that can be sent from any other country. That we know well in Ireland. There is the great town of Belfast, the most important of the great commercial towns of Ireland, which at this moment can hold its own, a town second only to the great towns of Liverpool, Glasgow, and the like. I had a serious remonstrance from the town of Belfast that I had not suggested any means of defending their Lough. They said, "We may be harried, as we were by Paul Jones in the last century, and we have no means of defence." My reply was that I would, to the best of my power, prepare a system of defence for that town, and I pointed out to them—and this shows, after all, that security is not very expensive—that with 46 new guns, at a cost of £65,000, the security of Belfast might be effected. I mention this to show the sensitiveness of commerce. I have no doubt whatever that in that great town, much money was lost in the interval of fear of what might happen during the American difficulty. I may say one word to our honoured guest, and it is this. He belongs to that body which has the control of the finances of this country; he will have the opportunity of hearing, as he has anticipated already in the most pleasant spirit, the professional opinions of the Officers present, who will address us on behalf of the country, and not from any idea of their own advantage; and when he returns to that body to which he belongs, and when he has the opportunity, as I hope he will have, of declaring his opinions, he will be able to tell them what the Officers of the Army and Navy think, and also what is thought by the people abroad, and that is that no sum is too large to be expended in the just defence of this country, if it be only properly applied, and well and judiciously laid out and administered, and in connection with that I am sure the honourable gentleman will do his duty.

General Adye, R.A.: Sir, I am desirous of taking a small part in this discussion, because it is a matter of high national interest, and is one which all Officers of experience must have more or less considered. I have myself long considered the subject which has been brought forward to-night, and have listened attentively to the remarks which the hon. gentleman has brought forward, and I agree in a great measure with the statements he has made. I agree, I say, in great measure, but not altogether in the conclusions at which he arrives. It appears to me, if I may be allowed to say so, that the weak point of his argument is, too implicit a reliance upon naval defence; he has assumed too much that the Navy will on all occasions be round the coast of England.

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* "The Strategy of Invasion," &c., &c., vide "Journal," vol. xvi, No. 67, page 153 *et seq.*

The chief points brought to our notice this evening are the great difficulties of an invasion, first, the embarkation; second, the voyage; and then the landing. Those are the great points to be considered. With regard to the embarkation, we hear often in these days that wars will be very sudden, will be undertaken by enormous masses, and will give no time for preparation if we are not ready. Even as applied to land operations there are some exaggerations in such statements; but at all events, maritime expeditions cannot be undertaken without long forethought, and what is of more importance, the necessary arrangements cannot be concealed. The assembling of a sufficient number of transports for the embarkation of such a force as should have any chance of successfully attacking this country, would require time, and must be known. In the case of cavalry and artillery, the ships must be carefully fitted for the reception of the horses, guns, carriages, ammunition, and stores; even for a short voyage in a stormy sea these preparations cannot be improvised. During the Crimean war it took two great naval powers, France and England, months to assemble a sufficient force, months of notorious preparation, and although they were absolute masters of the sea, they only succeeded in landing 50,000 men, with a moderate amount of artillery and little cavalry, in the Crimea. Then again, in looking at the map of Europe, we must bear in mind that there is only one country, namely France, whose geographical position is favourable for the invasion of England. The difficulties of maritime expeditions increase rapidly with distance. When the Duke of Wellington and Sir John Burgoyne pointed out our defenceless state in 1848, our harbours were feebly defended, our army was very small, our military preparations after a long peace had sunk to a low ebb, whereas France had a great army, and a fleet almost, if not quite, as numerous and powerful as our own, and therefore they were doubtless justified in pointing out that a successful invasion under such circumstances was possible; and it is owing partially to their wise warning that our state of preparation is far more satisfactory now than then. Then as to the voyage. When an invading army takes the sea, it is at once open to the dangers of weather, and almost to the certainty of attack. Nothing can be more helpless than a large fleet of transports crammed with men, horses, guns, and stores, and incapable of striking a blow in their own defence; and no covering fleet can adequately protect them. Our Crimean experience is again an instance in point. Those who were present must have been struck with the liability of our multitude of transports to hostile attack, and Admiral Dundas, the Naval Commander-in-Chief, fully anticipated that the Russians would take advantage of so opportune a moment and attempt to defeat the undertaking. I have no doubt that our Fleet on so critical an occasion would prove worthy of their ancient renown, and although I am not competent to give an opinion on naval tactics, still I can at all events bear testimony to the great power and efficiency of the armaments of our ships—armaments in my opinion superior to those of any other power, and I am glad to believe also cheaper in cost. The third great difficulty of invasion is the landing. We are to suppose that the hostile forces have succeeded in embarking and in crossing the sea, and that having eluded or defeated our fleet, favoured with fine weather they have reached our coasts. Their position at that moment would be very precarious. If we are vigilant as we ought to be, the mouth of every harbour, of every creek, of every river, should be barred to them by means of land batteries, torpedoes, and floating batteries. The science of torpedoes is still immature, but I know of no more powerful auxiliary for defensive purposes. Therefore, I say, that with proper precautions and with the timely warning which I maintain we must have, we ought to be able to compel our enemies, if they land at all, to do so on an open beach, and to commence a campaign without a base of operations. It is at this critical moment that they should be attacked at all hazards. On landing, they must be more or less in confusion, they must be weak in artillery, and therefore whatever perils they may have escaped, destruction ought to await them on the shore.

I think I have shown that I appreciate the arguments used as to the difficulties attending an invasion of this country, but we must not lull ourselves into a false security. We must not conclude that what is very difficult is therefore impossible; we must not rely on the one line of naval defence; we must be ready on land, and we must take care to maintain an army efficient and sufficient for the defence of the Kingdom. No nation would be justified in neglecting such obvious precautions; and when we consider the present state of Europe and the extent of our coasts, 100,000 regular troops and 140,000 Militia can hardly be called an extravagant total. Before leaving this part of the subject, I would mention that the defensive modern armaments of our chief ports are now being placed in position, and during the past year, heavy guns have been sent in considerable numbers to Portsmouth, Plymouth, Portland, Pembroke, Dover, Sheerness, Tilbury, and Gravesend, and that we are to a certain extent blocking up these great harbours as I have said ought to be done. Much more remains to be done, but it is a work of giants. We must also remember that these modern appliances of war are very expensive. We have gone through a great revolution as regards *matériel* of war, and therefore for a few years the expenditure must be great.

There is one other subject which can hardly be separated from this, and that is whether this country can altogether abstain from foreign wars. Although the present discussion is limited to defence, we can hardly refrain altogether from dealing with the question of offence. I understand there is a feeling that because our Army is small, and Continental armies are large, we must for the future altogether abstain from European wars. History does not appear to bear out that view. The campaigns of Wellington in Spain and again at Waterloo, would seem to prove the contrary. In those and in other celebrated wars, we were able with our naval and military forces, and in alliance with others, to exert a very beneficial influence on Continental affairs, in spite of the great Napoleon and all his armies. As in the past, so in the future, I think we must be prepared, if necessity arises, to bear our share of the burden of Continental campaigns, although I do not for a moment advocate the maintenance on our part of the vast armies considered necessary by some of the chief powers of Europe. Standing apart as we do in the ocean, free from many of the complications which beset our neighbours, difficult of attack, and with great naval and military resources, we hold a position of exceptional advantage, but in my opinion we ought not to attempt a policy of selfish isolation, and I doubt if such is in reality possible. As one of the family of European nations, we cannot absolve ourselves from the duties and responsibilities of that position.

Lieut.-Colonel CHESNEY, R.E.: I shall say a few words, confining myself as strictly as I can to what is laid before us, but it is impossible in the time allowed or indeed in any reasonable limits, to answer each point fully, as any one must know, who has heard the series of questions. I shall therefore only touch very slightly upon one or two of them, and in particular I would make one important correction—the only important statistical correction I shall venture on what Mr. Harcourt has said—as to the number of horses that would be used. I do not profess to be in the counsels of any chief of the staff of any foreign power, but I am quite certain that if one of the chief military powers now dreaded, was intending to attack us at present, the proportion of horses brought over would be infinitely smaller than that put by Mr. Harcourt. If 30,000 men came over from Germany on such a mission, I do not think at the outside they would attempt to bring with them more than 5,000 horses. They are quite as well aware as we are, of the difficulty of carrying horses, and it is their way to adapt the means that they use to the object in view.

Passing from that I come at once to the fourth question. When I said I was going to speak to-night, Captain Moncrieff who is behind me, suggested a point already in my own mind as to the way in which England might be surprised, and I will add to what he suggested a special consideration. We are governed in this country immensely not only by the power of the Legislature, but by the power of the press. If we were engaged in a war with a powerful maritime nation at the present moment, and any one of our great ports suffered seriously, the outcry would be instantly such, that our Government whether wise or foolish, prepared or behind-hand, would be compelled to hurry to that point which was being annoyed or attacked, a very large portion of the defensive forces of the Kingdom. Now it is not to be supposed that any reasonable soldier of any foreign nation would prepare to make a real invasion of England without trying one or two false invasions elsewhere, if indeed he did not make other serious ones.

I will go on to say a few words as to the last question, the most important of all. "Have the recent changes in the nature of armaments, as for instance, the introduction of steam, guns of precision, armour-plating, and torpedoes, increased or diminished the relative defensive power of England?" The answer to that is a plain and general one, and rises much beyond the subject we have before us. It is that the increase and the vast development of mechanical means, and of organising power which we have witnessed in the last half century, while it has made an advance in locomotion such as no one could anticipate, has also infinitely increased the advantages of those who make war. In that one point lies the great mistake of all those who have counted on eternal peace; they never recollected that the very means which they so hailed for bringing men, and the things which are useful and pleasant to men together, would also serve the purposes of war equally well. I have not the slightest doubt—without entering into any of those statistical details which would prove or disprove anything—I have not a doubt that any one who seriously considers the history of the last fifty years, must see that the power of making war has increased to an extent which Napoleon could not have dreamed of. It has been said before me by intelligent German Officers that Napoleon, had he had but one railroad at his command in 1812, would have conquered Russia with ease. I merely put that forward as one observation touching this sixth question. Apply it to the general subject, and you will see what I mean. But it was also Napoleon who said, what people who lecture upon war so constantly forget, that the "moral power in war is to "the physical as three to one." The moral sense of nations seems to me on this subject of invasions to be altogether changed. I will prove this by an example, and a very simple one. I spent a long day's travel lately in company with a very agreeable gentleman in Wurtemberg. I told him I was an English Officer, and he told me he was a manufacturer near the capital of Wurtemberg, one of the most peaceful parts of Germany, dwelling wholly inland, and living by manufactures entirely. He employed about 200 workmen. We got into considerable mutual confidence, and discussed military matters, of course speaking of the war. Just before we parted at a station near Stuttgardt, he said, "There is one question I "should much like to ask." I said, "I will answer it if I can." "There is," he went on, "a great deal of talk in our newspapers frequently about the invasion of "England. I should like greatly to know what is your professional opinion as to "the possibility of its being accomplished should such a thing be tried?" I passed from that man's society to go to Berlin. Near the west end of Berlin I saw before me apparently a new palace of handsome architecture and enormous size, about half the size of Somerset House. I asked what this was, and the reply was, "Oh, that "is the office that is built for the General Staff of our Army." "I suppose," I said, "that is where the administration of the Army is carried on?" "Oh no, it "has nothing to do with that; it is simply an office for Count von Moltke and his "personal assistants, and their library, to work out their plans." Now I have the greatest possible respect for Count von Moltke and his assistants, but I do not want to put before them voluntarily the problem which it seems to me would be put before them if we followed Mr. Harcourt's line of reasoning. For if we admitted that our 51 or 101 ironclads are to be held sufficient to defend our shores, the argument would not go to reduce our Army to 30,000 infantry, but it would leave us without any army at all; it would leave us simply dependent upon one line of defence, and it would put before an enemy the one single problem, how can you overcome or destroy temporarily this one line of defence; for this once destroyed, England falls? I had not intended to refer to a certain well known story—but Mr. Harcourt spoke of the Battle of Dorking, and what he has said compels me to do so, because he stated that the author supposes that there is no fleet. (Mr. VERNON HARCOURT: I said he had assumed the landing.) The author not only assumes but explains the landing. The English Fleet existed in its pride and strength in that story, but the English Fleet is supposed to be destroyed by some suddenly developed means of offensive fighting at sea. It seems to me a marvellous example of prescience, that at the time the author wrote he was not aware that in two different harbours of Germany there were constructing fleets of torpedo boats—not prepared against us—built with the intention and object, and with the great probability of destroying the French Fleet had the war lasted any longer. Surely this alone shows that it would not be fair to leave the whole country dependent upon a single naval line of defence, and to say to all the world, "If you can discover some means of destroying "our fleet, we place ourselves at your mercy, and give up for ever our position in the "world."

Mr. FOGGO: Mr. Chairman, if a non-member may be allowed to say two or three words, I should like to take the liberty of saying those two or three words. It appears to me that the honorable and learned gentleman has established a very great degree of improbability of an invasion of this country, but not, as I understand him to contend for the impossibility of it. I think—I say it with great deference—that he has not taken into account what I may call the unforeseen, the ordinary unforeseen. Now may I ask him what would happen in the event, for instance, of another Indian mutiny, which might deprive this country of a very large number of our standing Army? Then, in the second place, supposing an attack were made upon the Dominion of Canada, that would take away a large portion of the standing Army, as well as a large number of our ironclads. Again, under either of those circumstances, of an Indian mutiny, or an attack upon the Dominion of Canada, there might be a general combination amongst the European Powers, and that would, it seems to me, in a great measure, or to some extent, do away with the difficulties of transport. The other consideration that occurred to me was this: when the honorable and learned gentleman spoke of the certainty of our not being taken by surprise, and of our being able to station the "Great Eastern," or some ironclad, close to the port where the expedition against this country was being prepared, it struck me that it was not entirely beyond the range of possibility that we might be so—I would say, morbidly averse to a declaration of war—that we might possibly wait to see the enemy's ships start from the port before we thought it right to declare war.

Dr. HAMILTON: I shall not detain you long, but it strikes me that there is one fallacy which runs through the whole lecture which the learned gentleman has so kindly done us the honour to give us this evening, as well as the addresses of those Officers who have spoken, and that is this: that the honourable and learned gentleman takes it for granted that whatever enemy attacks us, whatever combination there may be among the Powers of Europe, they will attack us just at the time that suits us, and not at that time which suits themselves, in fact that their first act will be an invasion of this country at the very time when we are in the flush and pride of our power and strength. But how would it be, supposing there was this formidable combination which the learned gentleman has alluded to, and that there should be a twelve months' or two years' war before this attack takes place. Suppose a combination in which the United States should be an element, we know perfectly well the way we should be situated then as regards our Colonies, both as to Canada and our more distant possessions. We must fight to protect those colonies, we cannot stand by and look on, and therefore I think it would be worth while for the learned gentleman to take that into consideration when he next considers the invasion of this country. That is, how we should be after a war of one, two, or three years, and should we then be in a position to repel attack?

Captain JASPER SELWYN, R.N.: I rise to ask whether this discussion can possibly be closed this evening, and, if not, what time would be at our disposal for discussion hereafter, as I, for one, believe that there are a great number of Naval Officers and others present who are quite ready to prove, to Mr. Harcourt's satisfaction, that many of his bases are utterly fallacious and ungrounded? I particularly refer to the question of "transport" as one of the things which I myself am prepared to prove, if the meeting is of opinion that we can go on a sufficient time, otherwise I beg to move the adjournment of the meeting.

The proposal for adjournment having been seconded by Commander DAWSON, R.N., it was arranged that the meeting at its close should be adjourned to Wednesday evening, June 5th.

Captain SELWYN: I will now begin by saying that the question of armaments in this country has been too often mistaken so far, that we have got to consider the phrase of "bloated armaments" as one of every day occurrence. I want to show that armaments are a mere question, first of all, of an insurance on the increased wealth of the nation, and that if you do not consider them in that way, you will never arrive at a just conclusion as to how much you ought to expend on those armaments. The question the lecturer has asked, "why our land forces should be doubled" is, I think, to a certain extent answered by that fact alone, that our temptations to invasion have not only more than doubled, more than trebled, but have increased in an enormous and unprecedented ratio. But were that not the case, there would be still the other reason, that the rapidity of movement, the suddenness with which surprise may be forced upon us, has also increased in a ratio which we cannot estimate. Now, I am going to show you on conclusive evidence that we certainly shall very ill appreciate the powers of offence against us if we do not take into account the changed state of foreign nations. It has fallen to my lot lately to consider the lines of steamers going out of Europe. There are at this moment, and there are every day of the year, lying in two ports of Germany, enough steam-transport in the shape of 3,000, and over 3,000 ton vessels, to bring an army of 60,000 men to our shores. They are lying there, and their force is increasing also month by month from our own shipbuilding yards. The very best vessels that can be constructed in this country are sent over to carry on that great stream of emigration which goes from the northern ports of Europe.

Mr. HARCOURT: Will you give us the facts, for they are very important? I attach great value to facts. I suppose you refer to Hamburgh and Bremen?

Captain SELWYN: To Hamburgh and Bremen alone, without counting Stettin or any other ports. Each steamer is either of 3,000 or 3,500 tons burden, and can carry easily 3,000 men for a voyage of 300 miles.

Mr. HARCOURT: Will you kindly tell me how many vessels of 3,000 tons there are at Hamburgh and Bremen?

Captain SELWYN: According to the published list there are 25 vessels belonging to those two lines, without counting any of the other American lines. (Mr. HARCOURT: There every day?). And they are of 700 horse-power. There are only two vessels out at a time out of the 25. There is a much larger number there really; but those are the prominent vessels. I am speaking now of two lines of steamers alone. They are merely transports, as any seaman will know, and they carry easily 2,000 emigrants stowed away in bunks.

Mr. HARCOURT: You must allow me to point out that 300 vessels of that size were employed to carry 15,000 men to Abyssinia.

Captain SELWYN: We never have had 300 vessels of that size; those are the first vessels of their size and power.

Mr. HARCOURT: There were several vessels employed above 3,000 tons in the Abyssinian expedition.

Captain SELWYN: None of this power or carrying capacity, because they have new engines and new means of carrying coal. The next point with regard to that question of landing is, that those vessels have behind them at all times a *corps d'armée* of the number required, existing in those districts of Germany alone, and belonging to those districts, always there and always ready to be embarked at a very short notice, and we certainly should know nothing about the internal arrangements of the Germans as to marching down troops to their ports, they would take very good care of that. It is not to be supposed that they are going to tell us either when they are coming or where they are coming, which is much worse because, we have many hundred miles of shore to defend, and we do not exactly know which part they are coming to. Now, there happens to be a part of the coast of England which I should dislike particularly to refer to, but it is as nicely situated as possible for Germany. I do not want to teach everybody exactly where it is, but you can run the whole of your steamers' noses on to the beach without the slightest danger, and land every man over their bows; and gentlemen who fancy that landing is to be done as it was in the Crimea forget that, generally speaking, military and strategical reasons have forced sailors to land on beaches which they did not like, and that we must take into account, as the Germans are not such *dummenkopfs* as to fight the sailors on their own element, and tell them what to do, they will probably take their advice as to where a landing had best be effected. The blockades which were spoken of, involved the necessity of your steamers blockading that port, having full information as to what port was of importance. If that full information existed, if you could get all those ironclads of which mention has been made, manned and ready and started within a few hours' notice and they knew where to go to, some such idea might be possible, but that is not the case; and I do not see how you are to rely on ironclads which first may have been drawn off, as the other speakers have said, but which, secondly, do not know where to go to, are not ready, are not manned, and in most cases and in most times we have not the men to man them with and barely the guns to put on board. I do not want to go at length into this subject, but there are common precautions which can be taken, and which ought to be taken, for defending our shores. I do say it is scandalous that to this hour we have not got from 8 o'clock at night till 8 o'clock in the morning, any communication by telegraph between any coast guard along the shores and head-quarters. That is a precaution which is worth more than many ironclads, many soldiers, and many sailors, for it is early intelligence, and without that, the whole basis of your defensive power is in the air. We ought to be able at once to telegraph from any part of the coast at any hour of the night, any suspicious appearance off the coast. We are not able to do it, and I hope that will be a subject to which this lecture may draw attention, and that we shall not repose in fancied security on the showing of the great power which could be brought to bear, *if* all our forces were ready to oppose the enemy immediately he showed himself at that point.

Mr. VERNON HARCOURT: I should like to make five minutes' observations before the discussion closes this evening, as that may assist future discussion?

The CHAIRMAN: Perhaps Mr. Harcourt will allow me one word before he proceeds. There is one point, namely, that there were 400 ships which took the expedition to the Crimea, in which I think you are wrong as to your numbers. I hope you will be able to show that you are right; but I do not think there were so many ships. My impression is that there were 31 sail of the line, and 28 steamers towing 50 sailing vessels.

Captain HOSEASON: I think Mr. Harcourt has added the French to the English ships.

Mr. HARCOURT: I looked in M. Bazancourt's work, which gives the French transports very accurately. Mr. Kinglake's work, which is the only work I had, gives no numbers of the English transports. I looked in the "Annual Register," which gives 400, and also to some articles in the "Quarterly Review" as to the number of transports, and from that I stated it. If we can get accurate information upon that it will be very valuable. I have no means of getting authentic information. Of course the information of the "Annual Register" is not authentic.

With reference to the first observation made, the expedition to Civita Vecchia was mentioned. That was an expedition with no naval force to oppose it, and there the troops were stowed, as the French have often stowed them, "like herrings in a barrel," on board their line-of-battle ships. That I put out of the question, because if you are going to have a fighting expedition you cannot stow your men like that. That is true also of the expedition to Algiers; but what Colonel Adair mentioned is very valuable, as showing the length of time taken. He mentioned that it took ten days to go to Rome. The ordinary passage to Civita Vecchia I suppose would be two days; then you have a military expedition, which takes ten days going. To Algiers it takes fourteen days; that shows the length of time which is taken when you have even such a moderate flotilla as that. That is important. Colonel Adair said that there was one vessel to a thousand men in those expeditions. (Colonel ADAIR: One steamer and two transports is my calculation to every thousand men). With reference to Mr. Bazancourt's figures it was very different from that, because those figures I can rely upon taken from his work, and you will find the numbers very accurately given. There were 48 vessels of war of the French, of which a large number were three-deckers, towing 49 transports; that is 97 vessels, or say in round numbers 100 vessels to carry 25,000 men, and that is one vessel to 250 men, instead of 1,000, and that though you are employing line-of-battle ships for the purpose. With regard to the English transports I have not the figures. The French unquestionably stowed all their men on board the line-of-battle ships, and, besides that, they had 16 transports towed by Turkish men-of-war. Practically speaking the French had, including the great three-decker line-of-battle ships, one vessel to every 200 men. (A VISITOR: Each of these line-of-battle ships, the three deckers had 1,100 men of their own). These are the figures according to Bazancourt's book: Infantry 25,000 men, Artillery 2,000, Engineers 800; 1,500 horses, 68 cannon, 48 vessels of war, 49 transports, 16 transports towed by Turks. Those are the figures. Of course I cannot test them.

Now to pass to another point. It is said that we must defend our colonies. So we must; but how are we to do so? We are to defend them by sea. That is the question for the Navy. With the exception of Canada, all our colonies must be defended by sea, and, therefore, every argument which applies to an attack on our shores, applies with tenfold force to the attack on our colonies. No doubt you must detach a part of your Navy to defend your colony. Then arises the question, why do you detach part of your Navy? Because part of some other navy has gone there. Therefore you come back again to the whole question of the gross naval force. A detachment is a detachment as against some detachment from the other powers you have to deal with.

Colonel Chesney remarked with reference to the small number of horses the Prussians would bring. He said they would bring 5,000 horses. I take his authority on that subject, and I ask what is an army with 5,000 horses going to do in the presence of another army with 10,000 cavalry and 50 batteries of field artillery? How are they going to move? What are they going to do. All I can say is, if the Prussians come with 5,000 horses because of the difficulty of carrying them across, they must have altered their views as to the use of cavalry in this country. What are they going to do? An army with 5,000 horses all told, carrying its baggage and ammunition, everything it has got—is to meet an English army with 10,000 cavalry. How are they to poke their noses out of a beach on which they landed with 10,000 cavalry sweeping round them? One of two things happens: either the expedition is embarrassed because of a great number of horses, or, if it gets rid of that embarrassment, it cannot move because of the greater number of horses which the enemy has. It is said mechanical appliances have increased the powers of attack. Every one admits that; but has it not increased the power of defence? because that is the point that Colonel Chesney did not deal with. Take torpedoes, for instance. Have these increased the power of defence or attack most? (Colonel CHESNEY: Both). That is a question for scientific Officers to answer. My impression would be that they had increased the power of defence first. I should have thought the Thames more defensible since torpedoes have been invented than it was before. A distinguished relative of mine, a Naval Officer, told me that he believed the main use of the forts at Portsmouth would be simply as points for working torpedoes from; for all other purposes they were actually useless. That shows that torpedoes have increased the power of defence, because they have made the new forts of Portsmouth utterly useless. That is the opinion of many people.

Another point put by Colonel Chesney was, if the fleet is destroyed, and if the argument of naval force is good for anything, then it ought to dispense with an army altogether. But let me put the other side of the argument. If you assumed the fleet destroyed by one of those sudden developments which Colonel Chesney referred to—I cannot deal with sudden developments, because those are things I know nothing at all about—but if a Vesuvius arose all round the British Islands and blew up all the British Fleet, well then it is not 1,000 men that can defend England, or 100,000, you must have a million, because if your fleet has gone, there is no difficulty in landing. 100,000 men are of no use; there are a million of men on the Continent, and you must keep a million of men in this country; if you assume the entire destruction of the British Navy, it is no use having 100,000 men when France and Prussia together can easily send a million. Therefore, once assume the entire destruction of the fleet, and it is child's play to talk about 100,000 men. And that really is an answer to another gentleman who says I have not taken into account the unforeseen. That is a process I do not profess to understand. The hypothesis rather involves that a thing when it is *unforeseen*, is one that you *cannot foresee*, and to speculate upon the unforeseen is a thing that I confess is out of the province of my profession, though perhaps it may belong to the military profession.

With reference to Captain Selwyn's remarks, I thought I was going to be overwhelmed at least by facts, and I was told that every day there were in Hamburgh and Bremen enough shipping to embark an army as I understood of 50,000 men; but it comes down to this, that there are 25 vessels.

Captain SELWYN: I said belonging to two lines; there are twenty lines going.

Mr. HARCOURT: Twenty lines! The point I wanted to arrive at is how many vessels.

Captain SELWYN: I have given you merely the vessels belonging to two lines of steam ships which exist. (Mr. HARCOURT: Transatlantic?). They are not the South Atlantic lines at all; they have nothing to do with these, only to do with the two lines that run across round our shores.

Mr. HARCOURT: This is a question of fact, and it is a very important fact. It is a matter I have looked a little into; the mercantile marines of Europe are almost as important for the purpose as the fighting marines. This is a matter which may be ascertained in the course of a fortnight, and all I can say is—(Captain SELWYN: I have the list of vessels in my pocket)—I will give up all my questions and all my arguments if there exist in Hamburgh and Bremen one-half, and would almost say one-fourth of the number of vessels actually employed in transporting 15,000 fighting men to Abyssinia. (Captain SELWYN: Perhaps you will pardon me for pointing out that a vessel that has to carry coals and provisions to Abyssinia, is under very different conditions as to what men she can carry, to what she is when she has only to cross 300 miles of sea). That is quite true, but we know what the vessels carried when they went from Varna to the Crimea; but if any gentleman will look in the report of the Abyssinian Committee, he will see that there were vessels of 3,000 tons and upwards occupied in that transport, and if he will examine the list of those transports, and compare them with the mercantile marine in Europe, I will venture to say that the collective mercantile marine of Europe does not equal the number of vessels actually employed in the transport of that expedition. (A VISITOR: That was in a tropical climate). That is a point capable of being verified. It is a very important matter, and let us have it correct.

There is only one more observation that I will reply to, and that is a very important one—"that you cannot tell where the expedition is going to." I imagine when an expedition of that sort goes as slowly as we have already seen the expedition to Civita Vecchia went, it would be followed by swift despatch boats, who would be constantly keeping your fleet informed of their movements. This question of transport is a most important one, and I think, before the next meeting, it would be well to verify the fact as to the transport power of North Germany.

The CHAIRMAN: Before we part I hope you will allow me to thank Mr. Vernon Harcourt; for these questions are most important questions for the consideration of the general question, which is a subject Mr. Harcourt has rather avoided, and which I think perhaps he had better avoid. He has brought it forward in the most technical, the most military, and naval point which can be of interest to us. I think he calls upon us very properly, laying down general principles which are those he thinks right, for details to beat those principles; and therefore I think if we can bring facts either of the experience gained in expeditions to Egypt, to the Crimea, or even the invasion of England, at the various landings that have taken place, and can show that such things have taken place, and they are capable of again taking place, those are the points upon which Mr. Harcourt will be glad to have real information, and he will then form his opinion, and will be honest enough, I believe, to form his opinion truly. I thank Mr. Harcourt in your name for his kindness in coming here to-night.

Wednesday, June 5, 1872.

ADJOURNED DISCUSSION ON MR. VERNON HARCOURT'S PAPER.

MAJOR-GENERAL EARDLEY WILMOT, C.B., R.A., in the Chair.

The CHAIRMAN: Gentlemen, before we proceed to the adjourned discussion on Mr. Harcourt's paper, he has asked for a few minutes to make a short statement and a few corrections in the paper which he read.

Mr. VERNON HARCOURT: I shall confine myself entirely to figures, just to correct some of the figures which I gave before. There was a discussion (and I have no doubt we shall hear a great deal more of it) on the subject of French transport. The figures I gave of the French transport in the Crimea were taken from the separate volume of the "Annual Register," and from Bazancourt's work. The French expedition was composed of 15 ships of the line, 11 frigates, 14 corvettes, 5 other vessels, and 3 commercial steamers. That is 48, all used to serve as transports and towing 49 transports. They carried 28,000 men, 1,437 horses, and 68 cannon. Besides that, the Turks had 16 vessels of war towing 16 merchant vessels; that is 32 vessels in all, and they carried 7,000 Turks. The English expedition, of which I gave the figures loosely and very inaccurately, I have now had the opportunity of taking from Admiral Sir William Mend's paper read before this Institution. It appears that that expedition had 88 transports; that they carried 32,000 infantry and artillery, 1,240 cavalry soldiers, and 3,349 horses. Those are the figures that I find in Sir William Mend's paper.

I should also like to add some other figures which I have obtained, as I think they may be of use in the discussion. I dare say it is within the knowledge of many Members of this Institution, that recently the Government have been carrying cavalry from England to Ireland by sea instead of by railway, finding it more economical. I thought it was valuable to know what was the tonnage employed for that purpose, and the figures I have are these: ten vessels of 6,244 tons; in all 953 men and 835 horses carried. That gives an average of 600 tons per vessel, and the 6,000 tons carried altogether 953 men and 835 horses. You will find that that is on an average 95 men and 83 horses for each ship of 600 tons; or, if you take it in another way, 160 men and 140 horses per thousand tons. That is the recent experience of the carriage along the coast from England to Ireland. I have also a calculation of what may be done in the form of the new transport service. It is estimated that a ship of 1,500 tons, which I believe is now building, will carry a regiment; that is to say, it will carry 1,200 men of the foot regiments; and if you use it for cavalry instead of for infantry it would carry 138 horses and 200 men. That is what a ship of 1,500 tons is estimated to carry. Of course I need not say that that is without stores for any length of time; the carriage is only from England to Ireland.

There is another point which I should like to clear up. Question has been raised as to the numbers which I stated as to the troops at present in England. I believe the figures I gave were correct, but I should like to give them again so as to show exactly, as it was an important element in the discussion. At present in the United Kingdom there are 13,000 cavalry soldiers; that is to say, there are 1,292 household cavalry, and 11,889 cavalry of the line. There are 18,000 artillery,—3,000 Royal horse artillery and 15,000 Royal artillery,—that is the actual force in the United Kingdom. There are 4,128 Engineers, and there are 66,000 infantry, of which 6,521 are Foot Guards and 59,477 infantry of the line. I do not include the Army Service and the Hospital corps. That will make altogether a little over 100,000 men of all arms, cavalry, infantry, artillery, and engineers. That is the fact with reference to the existing force in the United Kingdom. As regards horses, I find there are 848 horses for the Household Cavalry, 6,757 for the cavalry of the line, 2,000 horses for the Horse Artillery, and 4,000 horses for the other artillery, and then other horses belonging to the other forces which I need not detain you with.

There is only one point more and it is so far a new point. I do not know whether any notice will be taken of it to-night, but it is a point I have recently raised, and I should be very glad if any one will discuss it. I have endeavoured to obtain an estimate of the annual cost of a first-rate iron clad like the "Devastation." I find the cost of the "Devastation" was £300,000; that the estimated wear-and-tear of hull and machinery might be taken at £16,000 for the hull, and £5,000 for the machinery; that her complement of men is 250; that the pay is £11,320, and the victuals £4,500. If you take that and divide the cost of construction by ten years, that would be £30,000 a year for the construction, £20,000 for the repairs, £12,000 for wages, £5,000 for victuals, and I add to that £3,000 for coal and other expenses, which would give altogether according to that estimate, the cost of building and maintaining such a vessel as the "Devastation," at £70,000 a year, were it to exist for ten years only and then to become superannuated. I venture to supply those figures as they might be useful in the discussion.

The CHAIRMAN: I will just call the attention of the meeting to the fact that there are a great number of Members who wish to address the meeting this evening, and, therefore, it will be absolutely necessary that all speakers should, as far as possible, confine themselves within the limit allowed for discussion, namely, ten minutes.

It was here ruled by the Chairman in reply to a question by Colonel Strange, F.R.S., that the discussion should be confined to the points brought forward in Mr. Harcourt's address, and not be extended to the letters which had appeared in the *Times* between the 15th May and that evening.

Captain SELWYN, R.N.: Mr. Chairman and Gentlemen, on the last occasion I advanced a proposition which I am here to-night to support. I have put before you on these two slates an accurate list obtained from Germany of the steam vessels then mentioned and their tonnage (the registered, not the real tonnage), and, in the case of the Norddeutscher Lloyd, their horse-power, also showing the number of vessels that belong to those two lines, and which are in active use to-day. I perhaps may have stated rather too much if I said that two only were out at a time, but I viewed it in this light, that two only are leaving at a time, and that the very slightest turn of politics would induce the retention of all the vessels going out, and the detention of all those which came in, and that consequently this tonnage might be regarded as available within a very short space of time. Enormous as it is, it is far beyond any possible requirement for transport of any army that would invade England. These vessels I am prepared to say, after consultation with the best authorities in the city on matters of steam shipping, can carry easily each of them 3,000 men, the Board of Trade regulations being fully complied with, and I need not say that these regulations involve the use of very much more space than would be required by well disciplined troops. Here are 36 vessels belonging to two lines, averaging 3,188 tons each. There are 15 more building for the Norddeutscher Lloyd line in our own ports, there are 4 more building for the Hamburg American line. Now then, will you consent any longer to listen to anything like the shams which are involved in saying that the question of transport remains where it was 20 years ago? Will you consent to consider for one instant the transport of troops in sailing vessels, or in small steamers for long distances, as to be fitly compared with the possibility of transport in these ships from a port certainly not 300 miles away from your own shores. I beg to draw attention also to the fact that these vessels belonging, as they do, to ports where a small draught of water is absolutely necessary, differ enormously from our own ironclads designed for the protection of coasts where shallow water is the rule and deep water the exception. They (the ironclads), unfortunately, draw very much more water than any of these ships; 18 feet is the draught of water of these vessels, 18 feet loaded with cargo, coal, and everything else for an American voyage. That compares very ill with those floating forts which may have their use in deep water, if they are not drawn away by a cleverly devised feint. But it is very easy to see that even when arrived at some points they may be of very little use if shoal-water and not deep-water points were attacked. I need only ask naval men to consider and to ask themselves what would be the result of a telegram to our outports to-day to assemble a fleet on any point of our shores—how long would they take to get there? or how long would they take to be manned and prepared? Perhaps I might go back still further, how long would the intelligence be in reaching the port? how long would it take in reaching London? Early intelligence is at the base of all success in war, and if we ignore that very first point of our defences, we shall do very unwisely indeed. I am not an alarmist, gentlemen, but I stand here to say that it is wise to consider how many shams there are in existence, how many things you are trusting to, which will break down under you, or pierce your hand when you lean upon them. I want that England should never have panics, and she never will have panics when she knows thoroughly what she has to rely upon, and relies thoroughly upon it. That can never be done without active exertion, without such knowledge as Mr. Harcourt's paper is calculated to draw out. I presume he came here for answers, and we are bound as professional men to give him those answers candidly, straightforwardly, even if they involve a reproach on our own profession. We cannot secure the country with the means now given us. Ironclads are well devised as floating forts, and ill-devised as coast-defence ships. I am not alone in that belief. The Royal

Commission reported precisely in the same direction; they said, "You cannot rely upon them, and therefore you must have fortifications." Where will you place your fortifications? Are you quite sure that your enemy will choose the points fortified at which to effect his debarkation? Let us then consider, and consider closely, all the possibilities of the question. I hope others will follow me, showing whether I am correct or not in estimating the number of men capable of being embarked. The question of debarkation I spoke of, and I was reluctant to point out to a possible enemy in the future, the exact spot at which this could be done; but I affirm again that there are 20 miles of coast in one place,—I do not say that there are not 20 miles in other places,—there are 20 miles of coast in one place where I will engage to run the whole of these transports, with their noses on the beach, and debark the whole of the troops they contain, in less than four hours. If you give us seamen, a low, long beach as the point of debarkation, and involve us in the question of putting troops, artillery, and cavalry into boats, and then taking them to the shore, we shall only do what is possible under those circumstances; we shall do what military men ask us to do, but that will not be what a seaman would do. If you ask us, on the contrary, to put our ships on shore with full command of steam in deep water, with no fear whatever, we will do a very different thing, and we will show a debarkation that has never yet been equalled in the world, and I presume what we can do, seamen of other nations well instructed, closely educated for the purpose can do also, at least it is not wise to except the possibility.

I have given you, then, the ships and their tonnage; everybody can read and verify them for themselves. If there be any error it is a perfectly involuntary one. I have sought the best sources of information, those, I am sorry to say, which do not seem to have been open to our own authorities, since the Institution was furnished through the kindness of the Board of Trade, with their reports up to the latest date, and I find that about one-fourth of the tonnage contained in this list of steam ships is ascribed to the whole ports of Bremen and Hamburg in the Board of Trade returns. I mention that to show how utterly fallacious bases will be, if they are taken on information so given. I think Mr. Harcourt also gets hold of a fallacy in thinking that the "Devastation" could be run for a certain price. He left out a very important element, which is that of galvanic action, and in which some of our ships not only cost more than he says for their repairs, but they actually go out of existence. The "Monarch" is reported to require £16,000 to be expended upon her to fit her for a four-years' longer cruise. (Mr. Harcourt: I allowed £20,000 a-year for repairs for the whole ten years). Of a ship costing £300,000. These are the repairs we get in one year, and I do not know what it will be in the next year. It will make her last a time; very probably it would. It is not satisfactory; it is a case which requires very closely inquiring into. There is one thing we certainly might do with these vessels. The Americans seem very fond of large ships, and I should suggest that as our cousins are quite ready to buy anything, particularly anything big, we should hand over to them all these useless vessels which we cannot use ourselves, and say, "Perhaps you on your deep-water shores can find a use for "them, but we have none on ours." If we want really to defend our coast it must be done by local defence, it must be done by careful concentration of the greatest power in small boats, habitually used by, and known to, the seamen at each port, and not by an accumulation of ironclads which dare not go into those waters where they are required.

Commander W. Dawson, R.N.: I am prepared with some statistics to bring before you with reference to the question of transports. I agree with the learned lecturer in many of the conclusions at which he has arrived, at the same time that I disagree with many of the premisses on which they are based. The questions put to us, assume that the Army exists chiefly for the purpose of repelling invaders; but it exists rather to prevent possible foes dreaming of the possibilities of invasion, just as policemen are to prevent burglaries rather than to capture burglars. We have not been invaded since the time of William the Conqueror; yet the British Army has had a good deal to do since that time, and many Officers in this room have been employed against a foe, and have written history with their swords if not with their blood, who did not serve under Harold. (Colonel Chesney: William the Conqueror or William the Third?) William the Conqueror; William the Third was not an invader, but a deliverer. The first question put to us is, "What are the character "and extent of the preparations necessary in order to such an enterprise as the "invasion by sea of a country possessed of a powerful fleet?" My reply is, that the first preparation is to get permanently rid of the British Fleet. Invasion cannot take place after merely getting rid of the Fleet for a few days or weeks. The invader must defeat the British Fleet, or get rid of it in some way, for a certain number of months. The defeat of the British Fleet may at this moment be an improbable contingency, but looking forward to futurity, we have no reason to suppose it to be an impossibility. When Charles the Second ascended the throne of England the British Fleet was in a much prouder relative position with reference to the navies of Europe than it is at this moment; but before that Monarch ceased to reign, we had to sink our ships at Sheerness in the vain attempt to prevent an enemy's fleet ascending the Medway and burning the dockyard at Chatham. There is no reason why history should not repeat itself. Last year the most magnificent army of Europe was found so well organised for defeat, notwithstanding numbers and appearances, that it melted like snow before the summer sun. If, at some future day, corruption, false economy, or over-weening confidence should organise the British Fleet for defeat, defeat will come, but it must be organised for it from within. The very first step for that purpose would be to endeavour to persuade the seamen and Officers of the British Fleet to believe what has been recently dinned into their ears by a portion of the press and by certain authorities as to seaman-like skill having been banished from the Navy three years ago, and as to there being no skilful Officers left; if the Navy would but believe those statements, depend upon it the nerve and pluck will banish from those iron hearts which are quite as essential for the defence of the country as ironclads.

As to question 2, "What would be the amount of shipping, &c., required?" I quite agree with Colonel Baker* that 3,000 infantry soldiers can be carried in a first-class merchant ship, but I think that when we are investigating questions of this kind it is not safe to take a first-class steam ship as a standard, we ought rather to take a second or third-class vessel. I have therefore endeavoured to estimate the transporting power that would be required, not only in ships but in tons, for such a force as Mr. Vernon Harcourt assigns to the invader; and comparing the estimate thus made with the tonnage employed for the Abyssinian expedition, I find that it gives 90,000 tons more, or about one-third more tonnage for the Abyssinian expedition than was actually employed, so that my figures may be taken as a considerable over-estimate of the transports that would be required by an invader. My estimate is 50,000 men, at 1,000 per ship in 50 ships of 2,000 tons each, making 100,000 tons. I take (with all due deference to the learned lecturer) Colonel's Chesney's opinion that 5,000 horses are quite sufficient for the invasion of England, and on this ground that it would be as unwise to take coals to Newcastle as to bring a large number of horses to a country like England, where there are plenty of open towns from which the enemy could help himself. That is a condition which ought to be kept in view when drawing lessons from the Abyssinian expedition, for our country could also feed the invading force. 5,000 horses at 300 per ship, a number which singularly enough agrees tolerably well with the estimate given authoritatively by the learned lecturer to-night, will take 17 ships or 34,000 tons; 50 batteries with stores, &c., 10 per ship, will take 5 ships, or 10,000 tons; and if we allow for provisions, stores, and non-combatants 30 ships of 1,000 tons each, 30,000 tons, that will make as an outside estimate a total of 102 ships of 174,000 tons. Now, comparing that with the Abyssinian expedition, I find from the figures given by the learned gentleman that the transports employed were 302,000 tons. On the basis I have adopted in providing transports for an invading force it would have been this: 14,000 combatants, 14 ships, equal to 28,000 tons; 50,000 non-combatants, 1,000 per ship, 50 ships, or 100,000 tons; 35,000 animals, 300 per ship, 117 ships, or 234,000 tons; provisions and stores 30 ships of 30,000 tons, making a total of 211 ships, or 392,000 tons, whilst there were actually employed only 302,000 tons, leaving a surplus of 90,000, or about one-third more tonnage than was used. I found by inquiring at the Board of Trade that the number of voyages made by German, Dutch, Belgian, and French steam vessels from various countries to London alone amounted in 1871 to 486 ships. Allowing that each ship entered the port of London four times in the course of the year, that makes 122 foreign steam ships trading with the port of London alone, or fully 20 ships more than is necessary to carry the expeditionary force referred to across the sea. Going, then, to another return of the Board of Trade, I found that the steam tonnage belonging to the Hanse Towns which entered the ports of the United Kingdom alone in 1869, three years ago, was 737,112 tons, being four times the quantity of tonnage required to convey the expeditionary force. But the Hanse Towns trade with other countries besides England, and the tonnage so employed is no doubt very great. That was in 1869. Since then three years have elapsed, and Captain Selwyn has put before you a long list of magnificent German steam ships belonging to only two companies, the great majority of which ships have been built since 1869, and we may suppose that many other steam ships have been added other than those given by Captain Selwyn. It would certainly be within the mark to credit the Hanse Towns with 1,000,000 tons of steam ships, or six times the required amount. A Parliamentary return shows that the amount of steam tonnage entered and cleared in the United Kingdom in 1869 from the United States was very small, owing to the destructively high tariff maintained in that country, but that from France, Holland, Norway, the Hanse Towns, and other countries amounted to 1,857,089 tons, or more than ten times the steam tonnage required by the invader. Now in the reply which Mr. Vernon Harcourt gave on the last occasion he said, "I will venture to say that the collective mercantile marine of Europe " does not equal the number of vessels actually employed in the transport of that (Abyssinian) expedition, *i.e.*, 302,000 tons. I am not aware what the collective marine of Europe amounts to, but here is that of one or two countries: France, 1,388,548 tons.

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* Reference to a letter in the "Times."—Ed.

Mr. Vernon Harcourt: If you will allow me to explain, I do not mean that those figures include the coasting trade, of course I mean ocean-going ships.

Commander Dawson: Invasion is not ocean-going work. It is coasting work, across the North Sea and English Channel. Take another small state. In Norway I find that the aggregate mercantile marine amounts to 1,200,437 tons. In Holland it is 588,196 tons. I wont go into the figures before me as to the few other states, for they all happen to refer to small states, and unfortunately I have not an estimate of the aggregate tonnage of North Germany, which would have been very interesting. Another point which must be taken into consideration is, that if the foe had the command of the seas he would help himself out of our ports; why should he not help himself out of our ports, and lay an embargo on English ships in his own ports?

Then question 4. "Is it possible to be taken by surprise?" I think it is quite possible to be taken by surprise if you are disarmed; and the logical inference to be drawn from the paper is that we ought to disband the whole Army. In that case, if we have no fleet, it would be possible to be taken by surprise. I do not mean to say it would be possible to wake up to-morrow morning and find 50,000 men landed on the beach; but an invasion might be organised beforehand; for instance, to invert the order of transport, our Board of Trade and War Office might, without anybody outside being aware of it, so organise transport that, supposing we had an organized army with a regular staff and proper central system and so on, which is a supposition we must take into consideration,—supposing we had that sort of thing, then arrangements might be secretly organised for sending 50,000 men to London or Liverpool and embarking them with provisions, &c., in, say seven days, with the dock accommodation we have got; and I suppose that they have dock accommodation across the water wherever they have those large steamers at Hamburg, and so on. I take the time for collecting the ships from the different ports after embarkation, for they would not all embark at the same port, and for sailing 300 miles as four days. With the aid of electric telegraphs it can be done in that time without any difficulty, using steam ships only. The time of disembarking in harbour, because I do not see the necessity of disembarking on the open coast, might be three days, which would give us fourteen days. Now I call fourteen days a surprise if you are disarmed.

The next question to which I would refer is Question 5:—"What are the con- " ditions necessary to the disembarkation of an army in the presence of an opposing

" force by sea and land, assuming the latter forces to be inferior in numbers?" Disembarking an army in the presence of a hostile force is a nautical evolution which it is the province of an Admiral to conduct, and it is a very common nautical evolution, and one which any Admiral who is worth his salt would conduct easily. It hardly wants explaining. Soldiers have been landed frequently in the presence of hostile forces, not only in olden times, but as recently as the very last civil war in America. Those who have studied that war know perfectly well that at Port Fisher Admiral Porter landed a considerable body of men in the presence of a hostile force, whilst occupying their attention with his ships. I suppose a few 35-ton guns (if they are not rifled on an unmechanical principle, warranted to burst their shell prematurely, and sink their own boats, and kill or drown their own men) would not only clear the beach but clear a good way inland. At any rate that is a nautical evolution which has constantly been performed in war, and, if the guns will stand fire and the shell won't break up at the wrong time, can be done again.

Question 6. "Have the recent changes in the nature of armaments, as, for " instance, the introduction of steam, guns of precision, armour-plating, and tor- " pedoes, increased or diminished the relative defensive power of England?" Now I think there is a great deal of exaggeration in the statements made about torpedoes. Defensive torpedoes have been, up to the present, untried in tidal waters and in wide open spaces. We have no experience with them under such conditions, and so long as they are all stored up in Woolwich we never shall have any experience of them. We must not build, therefore, upon a weapon of which nothing is known. I have no doubt, having studied this matter many years, that defensive torpedoes may become a very useful auxiliary, but they are not a substitute for any other weapon. Moreover, the torpedoes are not in position, nor have we enough to put in position. If an alarm were given to-morrow, we should probably apply what torpedoes we had in store for the defence of such naval ports as Portsmouth, Plymouth, Pembroke, the Thames, the Medway, and so on; but we could not possibly provide torpedoes to defend all the mercantile ports where an enemy might naturally attempt to land; and therefore I think we should lean upon a rotten reed if we think we shall have torpedoes exactly in the right position at the right time, so that an enemy cannot land anywhere. Offensive torpedoes represent a very considerable addition to naval force, but unfortunately they help to raise the weaker naval power up to the level of the stronger. That was the opinion of Lord St. Vincent seventy years ago, and I believe that is the opinion of those who have studied naval "torpedo-warfare" since. If you could banish offensive torpedoes from naval warfare altogether, offensive force would be measured by ironclads alone, and we should be relatively stronger than at present. At the present moment there is not a single offensive torpedo on the British Fleet, and there are very few naval Officers who have had the opportunity of gaining any experience whatever of the tactics to be employed in "offensive torpedo-warfare." At this present moment the instruction given in the "Excellent" and the "Cambridge" in electricity, almost raises the presumption that naval men are to quit their ships and to become Royal Engineers to defend our ports, for they are learning military submarine mining instead of naval torpedoing. An Officer of the Royal Engineers writes, "I have been recently six weeks in the United States, " and found that three special torpedo vessels were commenced, whose speed it is " hoped will attain 17 knots per hour; that ten powerful steam-tugs were fitted " with telescopic outrigger torpedoes, to be worked from the interior; that the " monitors, about 30 in all, were fitted with boom torpedoes; that every vessel, " whether corvette, frigate, or gunboat, in the United States' Navy carried a number " of outrigger and towing torpedoes, to be worked from the vessel itself; and that the " Officers of the Navy were being thoroughly instructed, in classes of twenty at a time, " in the art of practical torpedoing, the course of instruction lasting several months." The United States' squadron in the Mediterranean are even now gaining experience in the use of offensive torpedoes, and they are not the only foreign navy that is doing so. The only considerable navy in the world which is not gaining experience and acquiring dexterity in handling ships, so as to apply torpedoes effectively, is the British Navy.

The next point I would venture to go into is, have "guns of precision" improved matters? We are building ironclads like the "Monarch," the "Devastation," and the "Glatton," which are, or will be, armed with 25- and 35-ton guns, rifled on a most unmechanical system, which have never been tested for continuous firing. They are, therefore, untried weapons; they have not been tested in the usual way in which all naval guns have heretofore been tested, by a continuous rapid firing, and in which they will be tested in the day of battle. I have heard eminent artillery Officers say that it is a very wonderful thing that these guns stand a sea voyage in time of peace without bursting explosively, and that it is a matter for congratulation that they are only slightly injured, or, at the worst, temporarily disabled, by firing a few rounds for exercise at a target once a quarter. Meanwhile their projectiles break up prematurely in the bore, to the danger of friendly vessels. If you want to organize the Fleet for defeat, you must do it from within, and one of the ways of doing so from within is to provide them with guns of precision rifled on an unmechanical principle, so that the projectiles cannot escape from the gun without damaging the bore or disabling the gun—guns which have never been tried with quick firing, and which their advocates think are wonderful in that they can stand firing eight rounds every quarter at slow firing, and only require to be carefully examined after 250 such cool and quiet discharges, and which we are afraid to heat by discharging even 100 rounds of continuous firing on the same day, lest the extra and more rapid consumption of powder should lead to untoward results. (Question.) A question has been raised with reference to Point 6, and I venture to answer that question. I wish to show how the British Fleet may be organized for defeat from within by supplying it with bad tools. Unless the invader can thrash the British Fleet so as to get it well out of the way and obtain command of the seas, he cannot possibly invade this country. That is all; and I will not intrude further upon your patience.

Captain Hoseason, R.N.: In addressing you, Gentlemen, let me first take the opportunity of thanking the Council for inviting Mr. Harcourt to raise so important a question. The second thing I have to observe is, how deeply we are indebted to Mr. Harcourt for bringing this subject before the country. There are perhaps few civilians in England who could have treated the subject with as much ability as he has done, and although I entirely demur to nearly every statement he has made, yet at the same time I am under deep obligations to him, and I am sure the country ought to be, for raising so important a question. The first night on hearing his paper read I determined not to rise, wishing to have the advantage of reading the lecture submitted to our consideration. It is, however, not a lecture properly speaking, but a brief, and a most elaborate brief also, when we consider the series of questions so categorically put. We must, moreover, not forget that Mr. Harcourt has not been satisfied to submit the subject to us in this form, but has subsequently, whilst we had the paper under consideration, published still longer articles in the *Times*. It is true that we, the Members of the Institution, in reply, cannot travel out of the record, but must confine ourselves to the paper placed in our hands as printed by the Institution. I shall therefore not attempt to deal with the question as a whole, seeing that each Member is usually limited to ten minutes in his reply, all I shall seek to do is to throw the current of your thoughts into the proper channel, and direct your attention to the size and capacity of the steamers as constructed in the present day, as will be seen by the tabulated data I have placed upon the wall.* Mr. Harcourt has suggested a most important question for this Institution to answer, viz., that of the "conduit pipe." He has asked us, if there are a million of men over there, how that million of men can be brought over here, and he says truly that it is useless to talk of the number of men there are in foreign armies, without there are facilities for transporting them to this country. This is putting the question in a very fair way, and Captain Selwyn has replied to it most conclusively as far as Germany is concerned. But it is when Mr. Harcourt dwells on the difficulties of sea transport, and when reasoning by analogy he cites the Crimea, and Abyssinian expeditions, that I differ most materially with him; there is no analogy whatever between moving armies in such comparatively sterile countries as the Crimea and Abyssinia, and moving them in such a wonderfully fertile country as England; there is also no comparison between the difficulties of supplying an army from a single sea-base alone, caused by the general sterility of a country, and gathering a large portion of the supplies from a centre of a circle in a fertile one. A march of only 10 miles from a beach will bring an army to the centre of a circle whose area is 400 square miles, for the areas of circles are as the squares of their diameters, that is to say, a circle of 20 miles diameter has 400 miles area; consequently detachments despatched from a cavalry regiment placed in the centre of such a circle, marching only 10 miles out from a camp and 10 miles home, would have at its mercy the produce of 400 miles area of this fertile country. It is thus that the German cavalry so materially served to furnish supplies to its army in France. On the other hand in Abyssinia, where even grass and hay were not to be found within 80 miles of the beach, the mule or horse consumed in 10 days the 200 lbs. of fodder it was capable of carrying on its back, thus rendering invasion nearly impossible without the populace as allies, for an animal daily consumes, in round numbers, nearly ten times the weight of food that will support a man and keep him in good condition. The economy in the use of carts, wherever the country will admit of it, is very evident, as is shown by the tables I have placed upon the wall; nothing is therefore more important than having an ample supply of such means of transport to an army taking the field, and in due proportion to its anticipated wants; it being simple madness to rely on the ordinary resources of any country, however fertile or however rich. The moment an army is disembarked in an enemy's country, that moment it ought to be able to advance and seize upon an advantageous position. The English transports in the Crimean expedition Mr. Harcourt stated were 400 vessels. I pointed out to him at the time that he had included the fleet of our allies, he replied he had not done so, or "Certainly not." Now the document I produce on Admiral Sir William Mends' authority gives only 120 ships for the English instead of 400 (see Appendix).

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* For particulars on this and the following points, see Appendix at the end of discussion.

Mr. Harcourt: If you look at Sir William Mends' paper, read before the Institution, he says that the vessels were 400.

Captain Hoseason: 400 including the Allies, but not 400, as your document says, for the English Army alone.

Mr. Harcourt: I read the figures to-night.

Captain Hoseason: The fact is, that instead of going, even in those imperfect days of transport, with 400 vessels, we, the English, had only 120; and if you observe the list, you will find that half of these ships were sailing vessels. Mr. Harcourt called our attention to the fact that the length of the transit to the Crimea from Varna was only about 300 miles, although it took eight days to accomplish; and why? because every ship was tied to the speed of the slowest, and, as you will observe from the data I have supplied of the ten ships of the line, only two had screws, and there were 64 transports mere sailing vessels. Mr. Harcourt in his paper further says, that it was very calm weather; and so it was, beautiful weather no doubt for steamers, but very bad for sailing vessels, and the consequence was that they took eight days to perform a voyage which in the present day, and with such vessels as Captain Selwyn shows us the Germans have, would not occupy more than thirty hours. Now, the question of a successful invasion turns upon this point. There is no possible doubt of our faculty to move any amount of men, say 150,000 or 200,000, the only difficulty is to disembark them quickly on an enemy's coast. It is here demonstrated that there is no difficulty in moving the men, horses, and stores. Since this debate commenced, a Steam Company's agent has been summoned before the Lord Mayor for having exceeded the number of persons that ought to be put on board the London steamers running from London Bridge to Richmond. These vessels were only authorised to carry 470 passengers, and they took 530 each; and on that one day, that particular Company—only a fraction of the river boat navigation—took 80,000 people, and moved them 16½ miles to Richmond. Any German expedition coming to this country would be provided not merely with these immense ocean boats, which Captain Selwyn has referred to, but also with smaller boats for landing the troops,* and then there would be no possible doubt of their ability to land any amount of men rapidly if they were only once brought over here.

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* The able tactician of the German armies, as we have the past to prove, does not trouble himself to advertise during war for the resources he needs, he simply seizes

Captain TYLER: Mr. Chairman,—I feel equally grateful with the last speaker to Mr. Harcourt, who has been so good as to bring this subject before us, and I demur as much as the last speaker to the various statements Mr. Harcourt has put forward; but I differ from the last speaker as to the point of view from which we should consider the question before us. There is no doubt that the importance of this subject cannot be exaggerated; and to the various points which Mr. Harcourt has raised, clear and precise answers should be given; and not only so, but the inferences which Mr. Harcourt has drawn from the premises which he has laid down, require to be very carefully considered, and, if we are able, confuted. The errors of detail into which the hon. gentleman has fallen have already been partially established; but the errors of his general arguments have hitherto received scant attention; and to this point I propose in a very few words to address myself. Mr. Harcourt, in discussing this great question, attempts, in the first place, to tie us down to one part of it. He says, in his paper, "*The question to which I would ask*
"*your attention is the question of the defence of this Empire, and that question alone.*
"*That is the question which necessarily occupies, and has very much agitated public*
"*attention—that is, the question of the invasion of this country, in which I also include*
"*its colonies and its other dependencies.*" But the hon. and learned gentleman forgets what a man of his erudition must be well aware of, that in certain cases the true mode of defence is a judicious assumption of offensive operations. To take one example, the defence of Canada. It has often been urged that in the event of serious attack by the United States, Canada would be indefensible; and I have much regretted to hear such language from gentlemen, and even Officers of Government, high in authority both in Canada and in England. Remaining on the defensive to prevent invasion of Canada, with its long frontier and scattered population, by large or small forces at distant points, would, no doubt, be an impossibility. But there is another means of defending Canada, and a means which we must be prepared to adopt as long as Canada belongs to, and is an integral portion of the British Empire. That means, I need hardly say in this Institution, is by attack in sufficient force and with sufficient rapidity upon certain important ports and seaboard cities of the United States. If we are to maintain the honour and safety of the British Empire in America, we must be prepared to successfully invade, and to dictate terms of peace on American ground. It is neither necessary nor desirable to indicate here what the precise points of attack should be. It is sufficient for the argument before us to contend that a portion, and a considerable portion, of the land forces and of the naval forces at our disposal would be devoted necessarily to that object, and that, supposing we were at the same time engaged in war in Europe, a very large deduction from our available forces must be made on that account. But Mr. Harcourt also says, "*We have heard it said that we should always be prepared for*
"*all emergencies. Now, I propose that we should deal with this combination of cir-*
"*cumstances—that we should have war made upon us at once by France, Russia,*
"*Prussia, and the United States. If you can conceive all these countries combined,*
"*you will find that after putting ship for ship against theirs, it would leave ten iron-*
"*clads of the first order to spare as against them.*" Well, Sir, to this might be added trouble in India; and even if we are to be at war with only one or two of these Powers at a time, what I have said in regard to America applies also, although in different degrees, to other nations. If we are to sit still, as contemplated in Mr. Harcourt's argument, and to content ourselves with preserving this island from the risk of invasion, any wars in which we may be engaged will be long ones. It is difficult, indeed, to see how they would be brought to a termination. They would be destructive to us by their very duration; and these are no idle speculations. Wars have not yet ceased in the world. The visions of the greatest, the most

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them from his own countrymen, as well as from everybody else, and in the event of an invasion of this country, the Rhine and the ports of Germany would furnish all the small steamers he would require: if successful, a bill on the Chancellor of the Exchequer, to be paid in hard cash at the expiration of the war, as is now taking place in France, would be the way he would liquidate the debt with his fellow-countrymen. I need hardly point out how this mode of transacting business simplifies the art of carrying on war on a grand scale.—J. C. H.

rapid, the most momentous operations of war that are recorded in the history of the world have hardly yet faded from before our eyes. No one can predict that our turn may not come next, and that at no distant period; and if we are to maintain the honour and safety of our Empire—which is surely worth maintaining—we must be prepared to prosecute offensive as well as defensive operations in various parts of the globe.

Looking at the matter from this point of view, the argument which is at the base of Mr. Harcourt's inferences, entirely fails. It is not because we have a preponderance of ironclad ships, and are therefore safe at this moment from invasion in Great Britain, that we are properly prepared to defend our Empire and our commerce in all parts of the world. It is not because the French and the Germans have not, or could not purchase enough ocean going steamers between them—even if it were true, which it is not—to act as transports to carry 30,000 or 50,000 men, with cavalry and artillery, across the channel, that our Empire is safe. It is not because we could, if necessary, add to our fleet, that our honour is beyond insult, or our safety assured. Those results can only be obtained by preparation for rapid and decisive offensive blows, by combined land and sea forces, at the proper moment, in Europe or in America, if and when the hour of need shall arrive; and our Army is certainly not in excess of our needs for such operations, and for securing ourselves at the same time from all risk of invasion.

Another argument which has evidently been in the mind of the learned gentleman, and which is too often employed, is that as we cannot have an army commensurate in size to the armies of the Continent, we should not have an army at all with a view to offensive operations. But, Sir, our relative position as regards numbers, with reference to the armies of Europe, has been pretty much the same at all periods of time as it is at present. We have, at different times, sent small forces to the Continent of Europe, and with some success. We *have* heard of the victories of Marlborough, and of some little achievements on the part of Wellington and his forces in Spain and Belgium. As far as I remember, the battle of Blenheim was won mainly by the presence of 13,000, and the victory of Waterloo by not much more than 30,000 British bayonets.

Then, Sir, to answer the real question in Mr. Harcourt's paper, "Why is our Army twice as large as it formerly used to be?" Why have we now 100,000 men when we used to have 50,000? I am not quite sure that the numbers are correct, because I find that we could not bring 50,000 bayonets into the field at this moment if we wished to do it; but even taking them for granted, the most conclusive answers may be given to this question—first, because preparation in peace is more necessary now than at any former period for successful war. Secondly, because rifled guns, breech-loading muskets, railways, and telegraphs combine to make the operations of war far more rapid than they were at previous stages of our history. A country may now be conquered in as many months as it took years to conquer it formerly; and in the case of our own country, it is a question rather of days than of months if sufficient invading force were once to land on our shores. And, thirdly, because we have by offensive, combined with defensive operations, to maintain and protect, under the above circumstances, an Empire on which the sun never sets.

Not only, then, must we be prepared, if engaged in deadly strife at the same time in Europe and in America, merely to resist invasion, but we must also be prepared to assume the offensive in both hemispheres. Our fleets will further be required, not only to protect our colonies in all parts of the land, but also to protect our commerce on all the seas. I do not want to occupy your time by referring to the different parts of the world in which our ships are found and to which our commerce is carried; but I would ask you to remember them all in considering this question; and to think that it would be our duty, not, as the Americans did, to allow vessels like the "Alabama" to destroy their commerce during their civil war, but to fit out and to keep ships of war in all the seas of the world, which should prevent such destruction to our commerce; and, while we are doing all this, we must at the same time be undeniably safe against invasion from, say, two European Powers.

The British Empire contains one-fourth of the population of the globe. The mere protection of this island from invasion, though put forward by Mr. Harcourt as almost the only object, is only a very small item compared with the real necessities for our armaments. We must be prepared to maintain, offensively and defensively, the ships, the colonies, and the commerce for which Napoleon sighed in vain, but which it is our duty and interest to protect, alike from those enemies abroad, who would wrest them from us, and from those enemies at home, who would, if they could, starve our armaments, throw off our colonies, destroy our wealth, and dissolve our Empire. By God's help, we will vanquish both, and work out the glorious career that lies, if we are true to ourselves, before us.*

Captain SELWYN: I have recently passed through the United States, and lived with them, and tasted their hospitality; I should be very sorry indeed that it should ever go forth from this Institution that we should look upon them as anything else than temporarily alienated from us even in their worst moods, for I do not believe there is ever a chance but that the United States will hold out its hand to us the instant we are in any difficulty.

The CHAIRMAN: I do not think it was at all intended; it was simply an illustration of a principle.

Colonel ALCOCK: I should wish in a very modest way to be allowed to support the opinion just given by Captain Tyler, which is that the question which has been brought before us and which is now being argued does not comprise the whole subject. The question which is now before us, gentlemen, is the absolute force of States, that is, the absolute, the positive, the actual force which would be immediately available at any time and upon any emergency. Now it was seen by one of the speakers upon the last occasion that this does not include the whole question. I recollect perfectly well his having said, "But the learned gentleman has made no provision for the "unforeseen, the ordinary unforeseen." Gentlemen, that word "unforeseen" represents the relative power of Nations, which is quite a different thing from the absolute force of States. When a war begins, the absolute force of States is brought into contact, and in the progress of the war the relative power of the contending nations is gradually developed. I say that to compute and estimate the sources of that Power is one of the most difficult questions which any military or naval man can have, or ever has, attempted to accomplish or decide. Mons. Baillet gave his attention to this subject, and after having studied it for twenty years he published his work in 1868. He, in the most exhaustive manner, took in every condition which is included under the head of the relative power of nations, and at the conclusion of his work he tabulated the whole, bringing out the absolute force and the relative power of every nation. He there shows that the absolute force and the relative power of France was superior to that of Prussia. His work was published in 1868, after twenty years study of the subject. The Franco-Prussian war afterwards took place, and it must be palpable to everybody how wrong his conclusions were. He likewise puts England the first both in absolute force and relative force, and I believe that in the latter he is also wrong, as we shall be if we over-estimate our relative power; a point to which it appears to me that Captain Tyler has directed your attention. It is a clear mathematical fact that in the proportion in which the absolute force has to be called away into distant operations, the relative power must decline. Mons. Baillet was of course carried away by national vanity and the recollection of previous achievements, just as Captain Tyler has referred to our own at Blenheim and Waterloo. Mons. Baillet was led away by that, and likewise led into another mistake; he did not calculate that a nation with an imperfect commissariat was not quite certain of carrying a war into the enemy's country which would have compensated for that deficiency, and I say that we, carried away by our national vanity, our over-confidence, or blinded by the achievements to which Captain Tyler has referred, we may be destined to exemplify exactly the converse of what happened to the French—they calculated upon carrying the war into their opponents' country, and we assume that there is no nation on the face of the earth which, under any possible condition, can bring the war into our own; it is clearly our national duty to make it impossible, but that has not been done; and I say, gentlemen, that this is a cause for much consideration, and I will even allow myself to use the word "alarm." It is usual to say that we are no alarmists. Well, I say that I am an alarmist; but I take the word "alarm" according to its proper meaning, which is "*all' armi.*" We must not confound alarm with panic. "Panic" is an old word, which means a sudden, unaccountable, and contagious fear. Alarm is derived from *all' armi*, "*Aux armes!*" "Alarm," means the act of calling all good citizens to be prepared for the defence of their constitution or their country, and is one which will prevent the great calamity of a panic if any unexpected and sudden necessity should arise. Allow me to add one word: if ever we agree that the difficult and critical subject of the relative power of nations should be discussed, it would be discussed more ably in this room than in any other place, for there are men here who can understand it, and it is of more importance to this country than to any other empire in the world.

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* The following extract from a report on the "Dangers and Defences of New York," by Major T. G. Barnard, U. S. Engineers, and published in New York by D. Van Nostrand, 1859, is interesting, as bearing on this subject:—

"The recent war of England and France against Russia may illustrate my mean-"ing; for it has taught us what to expect were either of these nations to wage war "against the United States.

"No invasion of territory, no attempt at territorial conquest was made or thought "of; for it was well foreseen that no decisive results would flow from such means. The "war consisted exclusively in attacks on maritime places—great seaports—seats of "commercial and naval power. Such places, by their vast importance to the well-"being and prosperity of a nation, by the large populations and immense amount of "wealth concentrated in them, and by their exposure to maritime attack, offer "themselves at once as points at which the most decisive results may be produced. "Cronstadt, Sebastopol, Sweaborg, Kinburn, Odessa, Kertch, Petropauloski, and "other places of less note, were in succession or simultaneously objects of attack, "while such as the first named became indeed the true seats of war.

"Around Sebastopol assailed and assailant gathered their resources, and on the "result of the arduous struggle may be said to have turned the issue of the war. "Had it not been so decided *there*, Cronstadt would have been the next field of "combat, for which indeed the Allies had made the most enormous preparations.

"Is it not *certain* that in future all war of maritime Powers against the United "States will take a similar course? All territorial invasion being out of the ques-"tion, it is against our *great* seaports and strategic points of coast defence, such as "New York, New Orleans, and San Francisco—pre-eminently New York—that an "enemy will concentrate his efforts. Against these he will prepare such immense "armaments,—against these he will call into existence special agencies of attack, "which (unless met by an inexpugnable defensive system) shall *insure* success.

"The mere defence of the city against *ordinary fleets* is no longer the question; "but *through the defensive works to be here erected the nation is to measure its strength* "*against the most lavish use of the resources of a great maritime Power, aided by all that* "*modern science and mechanical ingenuity in creating or inventing means of attack* "*can bring against them; in short, in fortifying New York, we are really preparing* "*the battle field on which the issue of future momentous contests is to be decided.*"

Lieut.-Colonel CHESNEY: I wish to ask a question which may help to reconcile a difference of fact between Mr. Harcourt and Captain Tyler. Mr. Harcourt has given us some numbers to-night from a return of troops in England. I hold a return of the actual state of the troops as they were *in England* strictly on the 1st of May, which is strikingly different and in every part is under his, I would ask whether Mr. Harcourt's figures do not include Scotland and Ireland?

Mr. VERNON HARCOURT: I said the United Kingdom.

Captain HOME, R.E.: In his lecture, Mr. Harcourt told us he was a lawyer, and accustomed to elicit truth by the examination of friendly, and the cross-examination of hostile, witnesses.

Facts are, of course, the great things to be sought in dealing with such a question as that before us, but facts coming from a legal mind do not, I think, bear the same face as when they come from a judicial mind. Captain Hoseason has termed Mr. Harcourt's lecture a "brief," and a great judge has drawn attention to the fact that a legal mind seeks the triumph of the cause it espouses, a judicial mind seeks the triumph of truth. Now I think Mr. Harcourt has so examined his witnesses as (quite unintentionally, I am sure) to seek the former, not the latter. An example of this is the number of horses which are to be brought over. He supposes an enemy to come with a force of 50,000 men and 25,000 horses. The German Army invaded France, where there was no sea to cross, and where there was a country well adapted for cavalry, with one horse to six men. Now I think it should be shown why an army coming across the sea to a country ill adapted for cavalry, should come with three times the number of horses that the Prussians thought necessary to take to France. The next point was the Abyssinian expedition. We have heard something about the Abyssinian expedition to-night, but I really think it is almost worthless to go into the number of vessels and the quantity of coals, because there is as much similarity between the invasion of Abyssinia and England as there is between a naked Abyssinian and a clothed Englishman. The next thing was the Crimean expedition. I must say I fully expected Mr. Harcourt would tell us, after he had described the number of months the expedition was preparing, the number of days it took to embark, and the time it took to cross, and the time to disembark, I fully expected him to say that it was met on the beach, driven back, and defeated. But, Sir, the Crimean expedition was one of the greatest successes in the world. There we had two nations, thousands of miles away from their own country; they were an immense time organising the expedition; they took an immense time to cross, using sailing vessels; and when they got there they were met by three cossacks and a Staff Officer, who looked at them. They landed quite comfortably, waited on the beach, cooked their dinners comfortably, and made themselves happy; and then went and attacked the Russian Army that was in position, two days afterwards, and defeated it. That was a witness decidedly in favour of an invasion being possible, and not a witness against an invasion being possible. There was one witness, however, that Mr. Harcourt did not produce, and that was the expedition to Walcheren. That expedition was a very peculiar one in many ways. On the 19th of June orders were given to prepare for that expedition—I take this from the Parliamentary papers—and they sailed on the 28th of July. They carried 41,000 men of all arms. They landed on the 30th of July, captured Flushing, and might have taken Antwerp. And why might it have done these things? Simply, Sir, because the English had at that time the command of the sea, and because the French Army were engaged in the campaign of Wagram, on the Danube. There were very few troops at that part of France, as they were engaged elsewhere. That shows how easily such expeditions may be organised and carried out.

Mr. Harcourt has put certain questions, to which he wishes answers to be given, and, amongst the rest, he asks, "What are the character and extent of the preparations "necessary in order to such an enterprise as the invasion by sea of a country possessed "of a powerful fleet?" Well, Sir, I am perfectly free to acknowledge that if a fleet is present, and ready to dispute the passage, I do not think a passage could be forced, except by a very much more powerful fleet than that which attempts to defend it. But the question is, will the fleet be there? Now, Mr. Harcourt went through the ironclads; he told them off, one by one, to each other; and this one was to take that one, and, he said, "Here are ten left." But I argue that that is not war. The Emperor Alexander of Russia appears, before the battle of Austerlitz, to have reasoned precisely as Mr. Harcourt has done. He was a young man entering life, and, amongst other things, he is represented as being very ignorant of war. He appears to have gone into the question, and to have said, "Here is a Russian soldier; he carries so many rounds of ammunition and a "firelock; he is clothed the same as a French soldier; we put that Russian "against that Frenchman, and there is another, and so on," and as he told them off, the Austro-Russian Army, he says, "Here are 20,000 men left." After Austerlitz, what was the result? When the French General Savary went to see the Emperor Alexander, he said, "How was it whenever we met you you were three "to one, although you were over 20,000 inferior to us?" The reason of this was that the Emperor Napoleon, who commanded the French Army, had not the same idea of war that Mr. Harcourt has. Mr. Harcourt's idea of war is, that war is the art of being strongest: but Napoleon says *war is the art of being strongest at a given point, and that point the decisive one;* and unless Mr. Harcourt can make sure that he always will have his spare ironclads upon the decisive point whenever they are wanted, I think his argument falls to the ground.

There was a remark made by a gentleman on "the unforeseen." Mr. Harcourt referred to that, and said he really could not provide for what was "unforeseen." Well, now, I do not dispute with Mr. Harcourt for the meaning of the word "unforeseen," I think that is open to discussion; but I should like to remind the meeting of the words of a statesman in England who for many years has filled a considerable place in the minds of his countrymen. Mr. Disraeli, the master of happy phrases, says that there is nothing so possible, no, nothing so probable, as the unforeseen; and I think that is rather against Mr. Harcourt's idea. Take the case of one of our great races. Who wins, the foreseen horse of the papers, or the unforeseen horse? Generally it is the outsider, the unforeseen horse. Mr. Harcourt has really put himself in the position of laying tremendous odds on the favourite against the field.

Only one other point, as to an expedition made in the presence of a blockading fleet. In the year 1798, when the English Navy was certainly as much in command of the sea as it at present is, when the Fleet was commanded by Nelson and St. Vincent, there was an expedition from Toulon to Egypt. That expedition sailed on the 19th of May; it took 13 sail of the line and 400 transports, with 36,000 soldiers on board. Three English sail of the line and 4 frigates were despatched to observe it, but failed to fall in with it. On the 12th of June the French captured Malta; and on the 1st of July they landed in Egypt. On the 1st of August the battle of the Nile was fought. It is a very remarkable circumstance that Nelson, in hunting that fleet, actually crossed its track, went within 15 miles of it, and yet missed it, showing how easy it is for great expeditions to put to sea, even when blockaded.

Captain Wheatley: It will shorten the discussion very much if the question of transport is considered as decided already. There has been proof enough that it can be done.

The Chairman: I think the suggestion just now made is that we have heard quite enough about transport.

Captain Wheatley: Does Mr. Harcourt give in on that point?

Colonel Ouvry: If we look at these two slates, on which are given merely part of the vessels which would be forthcoming for the purpose of transporting an invading force, I think that the question is really decided as to whether an enemy could produce sufficient shipping to land a large body of men, even as many as 200,000, on this coast. I have not the slightest doubt of that. But I do not consider that that is the question. I think that the Navy, the Channel, as well as any other natural or artificial means of defence ought to be entirely ignored in looking at this question. I recollect an old song which probably may be known to many naval men here. I forget how it commences, but there are two lines in it with regard to invasion—

"And should their flat bottoms in darkness come o'er,
Still Britons they'd find for to meet them on shore."

Now, there I say lies the whole question. Have we Britons to meet them on shore? I say emphatically we have not. If the enemy had 200,000 men, or say more, if they had 500,000 on these shores, I say that we have not got men to meet them; therefore, in mooting the question of invasion, the fact that we have a navy ought to be totally ignored, that is, if England wishes to hold her place among the nations of Europe. It is not a question of our maintaining an army of 50,000 or 100,000 men, but it is a question whether we, as a nation, are in a position to meet other nations on equal terms according to the new state of things. I hold that the greatness of England is in the most precarious condition under the present system of a comparatively infinitessimally small army and reliance on her navy. There is only one means of meeting the case. It is not ironclads, and it is not torpedoes, but it is the acknowledgment of the necessity for general service; and if Englishmen cannot be persuaded to do this, their manifest duty, then they will have to take the consequences. Thus I agree with the learned gentleman, that if we look to that state of affairs, our Army is either infinitely too small, or it is doubly too large. I maintain that it is infinitely too small. I perfectly agree with Mr. Harcourt that you might just as well save half your fifteen millions, and have half the army you have got now, if all idea is abandoned of meeting an enemy in the field, and the policy of trusting to our "wooden," or rather, I should say, our "iron walls," is to be the one pursued.

Captain WHEATLEY, R.N.: I think we may take for granted that the possibility of transport has been sufficiently asserted. The next question is how to meet an enemy's fleet and expedition, I won't say from Prussia, but from any part of the world. Any expedition, under the present state of science and inventions, would scarcely attempt to leave the port without a swarm of fast sailing torpedo vessels—vessels, I should say, approaching the type of a broad-backed sword, held edge downwards. And such vessels would be required to guard our own convoys in the case of any future war. I dare say many people here will call to mind the exploit of Lieut. Cushing, of the United States' Navy, in the destruction of the "Albemarle." Let us take the "Thunderer," or the "Devastation," or any of our ships. These ships would have no terrors for such a man as Lieut. Cushing with fast sailing torpedo vessels, and I am bound to say we have dozens of men in our own service who in high-speed-torpedo vessels, would have no hesitation in running amuck amongst any fleet of an enemy's transports or men-of-war either. The only chance which a ship with guns has against a torpedo vessel is in being able to turn away from her and keep herself always at right angles to the torpedo's beam, so as to keep her constantly under fire, and by increasing her distance, so as to keep out of the sweep of the torpedo. I have alluded to the Harvey torpedo. Naval Officers are very insufficiently instructed in the use of these torpedoes at present, according to Captain Dawson's account; but we will take it for granted that in a short time they are quite as capable of manning these vessels as Captain Harvey himself, and he has been very successful. There is another sort of torpedo vessel (Question). The question is, I presume, how to stop an expedition from coming across. This very torpedo vessel, with its mysterious fish, by stationing herself—Captain Colomb has taught us to estimate the advantage of diminishing distances—this vessel, at a mile from the enemy's fleet, with its torpedo going seven knots an hour, suppose they are going three knots, her torpedoes will come in contact with the enemy's foremost vessel in six minutes. (The CHAIRMAN: Does not that rather partake of the unforeseen? May we not assume it would do that without a full description?) That is stated to be the case with the Whitehead torpedo. If the vessel is at an angle with the enemy's fleet, if the torpedo misses one vessel it must hit another, and that would cause a great deal of confusion and destruction.

Colonel BAKER, 10th Hussars: I am sure that we all regret very much to find that we are so thoroughly at variance with Mr. Harcourt. We must all feel a very great debt of gratitude to him for coming here into what he must have known would be a hot-bed of opposition (General GORDON: You speak for yourself); and I think Mr. Harcourt by this time will consider it is a hot-bed of opposition. I think that the error, if I may call it so, into which Mr. Harcourt has fallen has been this. He has come before us nominally to ask us questions relative to this important subject, but he has based these questions upon assumptions of his own; and if we can prove that those assumptions are incorrect, what is the value of the reasoning which is based upon them? I will not go into the question of transport, for the meeting has decided that this question shall not be entered into any more; but Mr. Harcourt has told us that he is not satisfied with the data which has been placed before him. (Mr. HARCOURT: Oh, yes, I am quite satisfied; the figures are most satisfactory.) I can assure Mr. Harcourt that I hold in my hand data, which I shall be very happy to give him, and which I think will alter the impression which he still holds relative to the power of the transports of foreign countries for carrying a sufficient army for the invasion of England. But the question of transport was not the only error into which Mr. Harcourt fell. He has given us certain data relative to the navies of foreign countries, and I think if you examine this table you will find that they are strangely incorrect. Mr. Harcourt, in his lecture, spoke at one time of three Prussian ironclads, but in his table he not only gives you the names of five Prussian ironclads, but he shows you five more building. When I refer to his table relative to the Russian Navy, I find an equal error; he has not reckoned the old vessels, which he has given us in his table, and he has not at all reckoned four others, which are described as building. When we turn to the French Navy we find also that he has not reckoned any that were described as building. Now I have no doubt Mr. Harcourt has gone into these figures. Does he know how many we ourselves are building at the present moment? If he does, he knows it is very small. Then Mr. Harcourt put forward an assumption of the force and constitution of force by which we should be likely to be invaded, and I think by this time he must be aware that that is not the sort of force that any military power would employ for the invasion of this country. He also assumed the force which we should have to repel the invasion, and he has fallen into this error, an error which he has repeated to night, he has reckoned the whole troops in Great Britain and Ireland as available for opposing a landing in England alone. Mr. Harcourt has quoted a branch of the service with which I happen to be connected; he quoted it once before, and he has quoted it again to-night, and he has named 13,000 men as the cavalry force of this country. But I need not tell practical soldiers that cavalry are not very useful without horses, and the force of horses, as he has shown you to-night, in Great Britain and Ireland, is only a little over 7,000. We know that practically this represents a very much larger force than we are ever able to bring into the field. I will guarantee that at the present moment in England alone the cavalry could not bring 4,500 men into line-of-battle. I will give Mr. Harcourt the returns privately, if he likes. (Mr. HARCOURT: That, I think, is the number of horses given in England.) Then, again, he assumes the landing of a very large force of cavalry, whereas we know that cavalry would be really an embarrassment to an invading army rather than an assistance to it. If an enemy ever invaded England it would be with an army composed principally of infantry and artillery, and principally of infantry. Infantry can be embarked and landed with the greatest possible facility. I have spoken to one of the leading steam-ship owners of Liverpool, and I have asked him to give me a good commercial idea relative to what such vessels as we see marked down on the slates relative to what those vessels could actually carry, and he says that 3,000 men is far below the mark. We have had all sorts of data laid before us here, and data which are likely to lead us into most erroneous calculations. For instance, relative to an invasion of this country, the same data have been applied to the transport of troops for only 21 miles, as for 300 miles That is evidently erroneous. You can place a very large number of troops on board for short voyages, and I can assure Mr. Harcourt I heard on very good authority that a French two-decker in going to the Crimea actually had on board 3,700 men. I am quite sure that Captain Selwyn and those naval gentlemen who have spoken upon this subject will agree with me when I say those troops could most easily be disembarked on the shore of this country. It is quite evident at the same time that if these infantry were brought over, guns could be brought over without horses. I have taken the trouble to make a calculation as to the actual weight each ship would carry relative to artillery and to infantry. I find that, taking the standard of a North German corps as at present organised, with all its infantry, guns, and carriages for transport, with 3,000 infantry, there would only be carriages and guns of 240 tons in weight, including the whole of the ammunition; that is to say, if you divide the men of a North German Army corps into the proportion of 3,000 infantry to a vessel of 3,000 tons, her proportion of artillery, of transport carts, of food for one month, and ammunition, and the weight of the men themselves, will only come to 694½ tons. The same authority I referred to above informs me that a vessel of that class will carry 3,000 tons of cargo. Although we know that artillery is more or less bulky, we also know that guns can be dismounted and packed away in a very small space, and carts can also be dismounted and packed in a comparatively small space; therefore I think we have proof to demonstration that vessels such as we see described here would actually carry 3,000 men and food for those 3,000 men, with their proportionate artillery without horses, and their ammunition.

We have now to see whether they could effect their landing. Mr. Harcourt is of opinion that even if our Fleet were absent from any cause, and we may imagine such a cause,—God forbid it!—such as the blockade of the American ports or anything of that sort, if our Fleet were temporarily absent, he imagines that other vessels, the other mercantile vessels of this country could still be taken into service. But you cannot suppose that invasion would ever be attempted, unless the Power which attempted the invasion, had a preponderance of naval force, at all events upon our shore; that preponderance of naval force, if it existed, would evidently prevent our mercantile marine from interfering with the disembarkation. But after assuming that they could gain a preponderance of naval force, we must look back I think to history to see what would be the chances of the success of an invasion. Now, if we look back to ancient history, we must remember that the very blood that we are so proud of, is really the result of three or four successful invasions of this country: Saxons, Danes, and Normans. Again, I believe if you go into the question you will find that there is no instance in modern military history of an unsuccessful invasion. Mr. Harcourt will correct me if I am in error, but I cannot remember a single instance of an unsuccessful invasion attempted in force. I think that is very important. Mr. Harcourt I believe holds the impression, and there may be some grounds of argument for it, that we should reduce our Army to a very small force and devote the expenditure to an increase of our Navy. But this is a subject which was considered very deeply in the time of Lord Palmerston; it was gone into very carefully, and the result of it was that it was believed that no dispositions could be made which would ensure our Fleet always being present at home; instead, therefore, of resting upon that supposition, we commenced the fortifications of Portsmouth and Dover. Since that time we have been engaged in the re-organisation of our Army; and although Mr. Harcourt may have some reason for arguing that if an invasion is possible at all, it may be possible to land a million of men as well as to land 240,000, or whatever the number may be, still you must remember that any nation attempting the invasion of this country, would balance the probabilities of the case. We and Mr. Harcourt have been at variance upon this one point. He assumes that invasion is improbable, and therefore we may effect reductions in our Army; we do not say that it is not improbable, we do not say that it is not difficult;—there are many operations in war which are exceedingly difficult, but which have to be attempted;—but what we do say is, that it is possible, and that therefore we ought to do everything in our power to make it so difficult that an enemy would not be likely to make it. Now, as I said before, it has been considered, and it was decided, that this could not be done by having a Navy alone without an Army. Since that time we have therefore devoted ourselves to our fortifications, and as you all know we have very recently devoted ourselves most seriously to the reorganisation of the Army, we have endeavoured to create a system which will, in years to come, give us very much larger reserves, and I think that Mr. Harcourt will see that although at present our Army may not be in a very formidable state, that when those reserves are created, when the Militia is more highly trained, and the Volunteers put upon a better footing, at all events it will be a very serious force for any foreign army to encounter after landing in this country; it would be a very serious force, because it is not probable, it is not in the least probable, that they will be able to land a million of men; taking the most favourable probabilities 200,000 or 250,000 will be about the maximum, unless our whole Fleet is entirely destroyed, and in that case I think that our present organisation would not prevent the invasion and conquest for a time of this country. But I will ask again, upon what principle are we to adopt this system of reduction? Is the country so poor that it cannot afford to insure its own safety? Economy is an excellent thing, but economy should be combined with efficiency; and if you reduce your establishment to such a degree that they are not effective in their several capacities, it must evidently be the very worst economy. I think Mr. Harcourt, since he came here, has changed his views very considerably upon certain points. I am quite sure that he does not hold the ideas which he held when he first put forward his views in this room in their entirety. A great many of his facts he will allow have been disproved. Here is one of his points about the relative mercantile marine of the North German States which I think it is really worth while to read to you. "If you examine the mercantile marine of great countries like " France, Germany, Russia, you will find that they have not got any. Russia prac- " tically has got no ocean-going steamers at all. She has got a certain number of " small coasting steamers of 200 or 300 tons burden. You will find that that is the " case with Germany also. I find in the returns that the mercantile marine of " North Germany is 48,000 men, which is about 12,000 less than the Royal Marine " of this country. No doubt at Bremen, and places of that kind, they have a few " large liners which go abroad; but if you come to examine the history of the mer- " cantile marine of all nations, except England, you will find it is practically insigni-

"ficant." I think Mr. Harcourt will allow that is disproved. (Mr. HARCOURT: Oh, no.) There is another fact I may call your attention to, viz., that if the mercantile marine of the North German States is not sufficient to satisfy Mr. Harcourt, still the mercantile marine of this country is enormous; the number of large steamers in this country is enormous, and it would be perfectly competent for any country that contemplated an invasion; and I am quite convinced if Germany ever did contemplate it she would make her provisions beforehand; it would be quite competent to them to buy steamers in this country for that purpose before declaring war. But as the question whether it is worth while to maintain our Army in a state of efficiency or whether it is not, I think you will all agree with me that it is not only a duty, but that it behoves this country in every possible way to take such measures and precautions, both with regard to her Army and her Navy, that her Navy shall be superior in strength to any force which is likely to be brought against it, and that the Army is also placed in such a position that it could with reasonable probability resist the force which with reasonable probability could effect a landing.

Vice-Admiral OMMANNEY, F.R.S.: I am very sorry to hear that my brother Officers have totally demurred to Mr. Harcourt's paper, because I think he is a friend to the Navy, and he has thrown out one suggestion which I think is a very valuable and important one, and which I hope he will follow up. He recommends that 200 or 300 gunboats should be provided; if that is done, it will be one of the greatest securities we can have to prevent any invasion. If we had 300 gunboats with means of steam propulsion, such as those which we are now constructing, each mounting an 18-ton gun, I think that alone would almost prevent an invasion of this country. Differing as I do as regarding the facility of landing 3,000 or 4,000 troops from one ship on an enemy's coast, I must say I do hope that when the enemy try to invade us they will come in ships carrying 3,000 or 4,000 men in each ship, because I believe myself that it would be impracticable to land 3,000 or 4,000 men fit for service from a ship, and to disembark their baggage and stores under 24 hours. I do hope, Sir, that from your place in Parliament you will advocate that which you put in your paper, and thus provide us with 200 or 300 formidable gunboats.

Lieut.-Colonel CHESNEY: I rise to say a few words, and would, in commencing, refer to what was said at the beginning of this evening with regard to a protest against shams. It seems to me that if we were, as suggested, to totally ignore all that has been said and written on this subject since we last met—not only in this country, for it has been largely discussed over in Germany—we shall be committing ourselves to a sham which might well send us all away ashamed of the unreality of such a proceeding. I am not too careful to ask how far Mr. Harcourt's views may have changed, nor do I wish wholly to force conviction upon him. Rather I think we owe him a deep debt of thanks for giving the whole country by its voice in the press the opportunity of stating straightforwardly what is the public mind upon this subject. And whatever the opinion may have been formerly about the utility of the Army, anybody who has studied the question as it has been discussed during the last three weeks, cannot doubt what it is now. The country is resolute in its determination, without rushing into either any wild excess or hasty reduction of armaments, to see for itself that it shall get the value of what it now engages for, so that having paid a handsome sum down it shall secure a handsome service for that sum; and it is plainly not less resolved that it will continue so consistently to act in this direction, that the possibility of the panics which have disgraced us over and over again in the eyes of all Europe for the last 15 years, shall vanish from our political horizon. I repeat, therefore, we owe Mr. Harcourt a real debt of gratitude for giving not only ourselves, but tens of thousands outside this Institution, the opportunity of considering whether really we have done too much, and of deciding deliberately on this consideration that too much has not been done yet, that we are only in fact now coming up to what is really required for the maintenance of our national security.

Captain COLOMB, R.N.: I wish to say that I am one of those who do not form part of the "hot bed" that has been described, for I find myself in very close agreement with much that Mr. Harcourt has said. I do not think that the "abstract" of questions propounded, which has been circulated to us, expresses the real points of Mr. Harcourt's argument. I understand him to propound two questions, first: is invasion probable? and secondly, admitting it to be so, what is the proper method of defence? I think we must admit—at any rate, if Mr. Harcourt does not, the Meeting on both occasions seemed to me fully to admit—that there is great possibility of invasion, and I think that the military speakers have very distinctly proved that military preparations on shore will not prevent invasion. The only argument I have heard on that head which seemed to me to go to the point, was Colonel Baker's. He proposes that we should have such a military establishment as would create a feeling in the minds of our enemies that the difficulty of invasion would be very considerable. So far I think military preparations are right, but I think it seems most distinctly shown that, take it how we will, military preparations on shore do not suffice to prevent invasion. As was said by a previous speaker, there was no record of an invasion undertaken which did not turn out successful. (Captain Tyler: The Spanish Armada). I am merely quoting a previous speaker, I am not going to argue the point myself. Now I think that another point has always been put forward, and that is the great possibility of the Navy being out of the way when the occasion comes, but looking to history, I never see that the Navy was out of the way, but it had a particular policy in those days, which appears to me not to govern it now. Its policy then was to seal its enemies up in their ports. I take that to be the policy which will form the proper defence against invasion now. I look with considerable alarm upon the many plans that are put forward for retaining ships on the shores of England. I believe what would happen in that case would be false alarms, the withdrawal of the force from one point to another point; but if you provide sufficient force—and it does not require such a very large force—to seal the coast from Gibraltar to the Cattegat which we commonly did in the old war, we are quite safe from invasion, and we are safe from a danger which is far greater than that of any invasion in my opinion, we are safe from the danger of blockade. Looking at this question, it seems to me really our greatest danger now is the danger of blockade. You may take it that in round numbers the population of the British Islands has doubled within the century, but the commerce has multiplied eight times; that is to say, every person in England is four times as dependent on the commerce of England as he was during the last war. Then—I will not say what the figures are—but we are much more dependent for food than we were. (Captain Hoseason: One hundred and eighteen millions sterling of eatables imported every year). In the week ending the 25th of May, 23,000 tons of wheat came into this country. We cannot of course imagine what the state of this country would be with even a partial blockade; but if we take the only time in modern years when a partial blockade was attempted, I allude to the mutiny at the Nore, and if we remember what the state of alarm in the country was simply because the Fleet had the Thames in its hands, we can gain some sort of an idea of what the alarm and state of the country would be, were we to leave ourselves open to blockade. The only way to avoid being blockaded ourselves is to blockade our enemies, and therefore by throwing our force upon the enemy's coasts instead of retaining them on our own, and depending chiefly upon our own Navy distributed in that way, we should most effectually guard ourselves against invasion, and should also save ourselves from that far greater danger, blockade.

Mr. Vernon Harcourt: I may now perhaps be allowed my ten minutes for reply. In spite of my having come into a "hot bed of opposition," I have never for one moment regretted that I came here. People say vegetables grow in hot beds, and there is no reason why men should not grow in them also; it tends to promote ideas.

It has been said that I have changed my mind. Well, there is no reason why a man should not change his mind, and upon some points I have changed my mind, and upon others I have not. I have no doubt whatever on the question of transport that in the observations I made the other night I considerably exaggerated the difficulty. At the same time, after all that has been said upon the subject, I cannot at all agree that the difficulty has been entirely removed. I will first take the figures which I noted down carefully. Captain Dawson took my hypothetical army and estimated the amount of tonnage and ships it would take to carry it, and the figures he gave were 102 ships and 174,000 tons. When I look round to Captain Selwyn's fleet which is to carry any army to invade England, not my little army but a great army of 200,000 men—I think somebody else said 400,000, or any number of men—if I compare Captain Dawson and Captain Selwyn,——

Captain **Selwyn**: I did not say that, I only said they would each carry 3,000 men.

Mr. **Vernon Harcourt**: Captain Selwyn gives us, I think, 35 vessels in those two fleets.

Captain **Selwyn**: Thirty-six, and 15 more will be ready within a year.

Mr. **Vernon Harcourt**: I will take those that are ready at present, that will be upwards of 100,000 men. My army was very much less than that, it was less than half that, and Captain Dawson's figures require for that 174,000 tons and 102 ships. Now what is the tonnage of Captain Selwyn's great fleet which is to carry upwards of 100,000 men? Why, it is 108,000 tons, taking them at the average of 3,000 tons a-piece.

Mr. **Knox**: Captain Selwyn only gives a few ships of the Hanse Towns. The tonnage of the Hanse Towns in 1869 was 700,000, but now it is 1,000,000.

Mr. **Harcourt**: I am taking this fleet on the two slates, and I say, according to Captain Dawson's figures, it would not carry one-half of the army which I have suggested, of 30,000 infantry and 10,000 cavalry; he has taken my figures and carefully worked them out, and he says it requires 174,000 tons to carry them. Well, this great fleet which is to convince me that it can carry any force, evidently wont carry one-half of the small army that I have suggested, according to the comparative figures of Commander Dawson and Captain Selwyn, therefore it is not those figures that can convince me of the unlimited powers of transport, even of the fleet which is there exhibited.

I was asked by Colonel Baker whether I was not convinced that I was entirely wrong in saying the mercantile marine of Germany was comparatively insignificant. I do not know whether it was an error of mine or an error in the report. I was speaking, of course, of steamers, because we have been dealing with them all throughout. I meant to say certainly steam navy. I am not now talking of sailing vessels. I have before me a paper of the mercantile navies of the world, a letter addressed to the Editor of *Lloyd's List*, written, of course, without any reference to this question, dated 6th October, 1870, and it compares the steam navies of the world. Now the English mercantile steam navy has 2,426 vessels which is just 58 per cent. in point of number of all the steamers of the world, and it is 59 per cent. in point of tonnage. The American is 14 per cent., and what do you think is given in this table as the mercantile marine of Germany, to show that the statement that I made the other day was not made altogether without foundation? "The German marine is 127 in number, and 105,000 in tonnage." I have no doubt it has been increased since, I have no doubt it is much larger than it was then, but I am showing what proportion it bears—105,000 in tonnage—therefore the whole of the mercantile marine of North Germany would not have sufficed to have carried one-half my hypothetical army, and those vessels average 827 tons a-piece, taking the average all over them, and the mercantile marine of Germany, whereas that of England was 59 per cent. of that of the world, that of Germany was 3·7. No doubt the thing has been exaggerated, but I confess, taking Captain Dawson's figures, there is nothing to show me, upon those two slates, that there exists at this moment in North Germany a tonnage according to the estimate of Captain Dawson which would carry an army such as I have suggested. We are told that you may put 3,000, or even more, upon these vessels, and that is said upon the authority of some gentleman in Liverpool, who I am not aware has had experience in carrying troops. I have laid before you some figures of what our own Government are doing at this moment, and what the tonnage is. Now they have estimated that a ship of 1,500 tons will carry 138 horses and 200 men, and that is a measure of actual fact. [A **Member**: On a long voyage.] No, between England and Ireland. I am speaking of the transport between England and Ireland. I also gave these figures, I think it was before Colonel Baker came, that these vessels of 1,500 tons were constructed to carry a regiment of infantry, 1,200 men, or they would carry 138 horses and 200 men. Taking it upon the average of the trips that have been made by ten vessels of 6,244 tons, they have carried 953 men and 835 horses, that is 95 men and 83 horses per ship of 600 tons. Those are very different figures from those that have been suggested, but that is what the Government is now doing, and has been doing for many months in transporting troops at a cheap rate to Ireland, instead of carrying them by railway. These are the actual facts, as we can do it between ourselves, and do it as we think to the best advantage. That works out 160 men—of course I am giving the figures of carrying cavalry upon all these journeys, 160 men and 140 horses per thousand tons.

I have dealt with the figures given by Captain Selwyn and Captain Dawson, and I now come to Captain Tyler. He says that we are to defend Canada by invading America. I do not enter upon that subject, it seems a large one, but at all events there is one country that does not seem to be very much afraid of being invaded by us, and that is America, for America is a country not wanting in energy or wealth, and yet America, which Captain Tyler proposes to invade for the purpose, if necessary, of defending Canada, has no navy to speak of, and keeps an army of less than 30,000 men. Therefore, at all events, America is not in dread of invasion by a country which possesses an army at least three times as numerous as its own, and those fears, and perhaps that absence of prudence in respect to insurance, has not yet entered the American mind in reference to that invasion which Captain Tyler seems to have contemplated. I do not know if we can invade America, if so I suppose America can invade us, yet I have not heard in any of this controversy a discussion raised as to the number of thousand men we are to keep on foot to defend us against American invasion, because America has much larger vessels, no doubt, in many respects even than Germany. [Captain TYLER: No.] They have had since the late war, no doubt. I have seen myself in Liverpool some of the American liners; I believe since the late war the mercantile ships are of a much lower order, but you will find that we have about six times the mercantile shipping and steamers of that of Germany. (Captain TYLER: Not large ocean steamers). The average of tonnage is rather higher; the average of their 600 steamers is 860 tons as against an average of 827 tons over the 127 steamers of Germany, therefore in fact they are about five times as large in number, and a little larger in tonnage.

I shall not follow the criticisms of Captain Home. No doubt he was speaking to an audience where he was sure of a majority, and he thought it right to speak with severity of the "legal mind." I shall not attempt before so unfavourable a jury to defend the legal mind, only all I can assure Captain Home is, if ever he comes into our legal circle I shall not follow his example, and I shall not choose that opportunity for making an attack upon his profession. There is only one remark that fell from him which I think it is necessary that I should notice. He says the art of war does not consist in being the strongest. He made that remark with reference to some of the campaigns of Napoleon. That seems to me rather in my favour, for if the art of war does not consist in being the strongest, why are you to multiply your forces to this extent? I thought that we were to multiply our Army because it was assumed the most numerous army was most likely to win, but he says no, it is the outsider that always wins, and not the favourite. Then why should not we be the outsider, if it is the outsider who wins? I cannot conceive why we should endeavour to put ourselves in the position of the strongest, to make ourselves that favourite which is sure to be defeated. Captain Home's argument is an argument for having no army, because he says it is not the strongest that will win the war. (Captain HOME: Strongest at the given point). Then let us be strongest at a given point. That argument is one which it appears to me we ought to avoid. Certainly I have failed, no doubt from the defects of the legal mind in apprehending the art of war, and if the art of war does not consist in being the strongest, why surely all these armies are more than ever in vain.

Now, I have few remarks to make upon the important remarks of Colonel Baker. I think Colonel Chesney said something about my having confused the figures with reference to England and Ireland. I may as well correct that. I stated I think the United Kingdom, and I gave the figures. The men of all arms in England are 1,292 household cavalry, and 11,889 cavalry of the line. I am told that if the cavalry have not got horses they are no use: but I do not know why we do have so many more cavalry than we have horses if they are of no use. I thought we kept fewer horses, because when you had a good cavalry soldier you could mount him in a short time; if it is true that a cavalry soldiery is not worth counting if he has not a horse belonging to him, it seems to me we ought to diminish the number of our cavalry by one-half. Therefore I think that, at all events, is a valuable hint. Inasmuch as we have got at the present moment 13,000 cavalry and we have only got about 7,000 horses, then it is plain that if the cavalry soldiers without the horses are no use, we ought to cut off about 6,000 cavalry soldiers who have no horses. (Colonel OUVRY: Or provide the horses). Or provide the horses. In one way we must have a greater expenditure, in the other way we might have a larger economy; but it is quite plain that this existing as it stands, cannot be right, because we must have 6,000 men who are of no use at all. I am going to figures as they stand. There are 13,000 cavalry, of which about 9,000 are in England; that is pretty near the figure at which I put it: 2,580 Royal Horse Artillery, 3,000 Royal Engineers, 42,000 Infantry, including Foot Guards, making in all about 72,000 men and about 27,000 in Ireland.

Major-General Sir PERCY DOUGLAS: That includes the Indian depôts, does it not?

Mr. HARCOURT: Whether it includes depôts or not I cannot say.

Sir PERCY DOUGLAS: I may say that it does, and that they number 9,000.

Mr. HARCOURT: But I suppose the Indian depôts can fight, at least I hope so; they are very little use to send out to India if they cannot, therefore I do not exclude them at all from my calculation, because, if you have troops fit to be sent out to India, I suppose they are troops that could fight for the defence of England.

Sir PERCY DOUGLAS: It merely represents the potential number we may raise in the year in order to recruit the casualties in the regiments in India; it represents no fighting power at all, they may not be in existence.

Mr: HARCOURT: These are the actual troops on the 1st of May, the date given by Colonel Chesney, the actual troops in existence under the colours in England. Colonel Chesney, no doubt, is familiar with the paper.

Sir PERCY DOUGLAS: A great many of them have not even the clothes.

Mr. HARCOURT: I think Colonel Chesney will admit these figures that I have taken are given from a correct and official paper.

I do not know that I have anything more to say. There is one point upon which Colonel Baker has I must say convinced me, and has brought the matter very strongly before my mind, and that is the very great difficulty of preventing a landing by land troops, that is to say, that the power that troops embarked have of moving along the shore, and so baffling the pursuit of land troops, is very great. I think Colonel Baker has brought out that fact in a very strong manner. I confess the impression left upon my mind is that if you have got 3,000 men in one vessel, or 30,000 men in ten of these vessels, I should like to fight those 30,000 men when they were inside those vessels, rather than when they were outside. The more men you get into a ship, the more I should like to fight them in that ship, for if you get all your eggs into a basket of that kind they may be cracked by a single shell. The Prussians are prudent men I believe, and how far they would venture 3,000 men in a ship which a single shell thrown from a gunboat, or from a Cunarder with a gun on board, might send to the bottom, is a matter which of course scientific people will judge of. When you have got, practically speaking, a whole *corps d'armée* put into ten of these boats, that a single gunboat with an 18-ton gun on board, if it once got at them, would send to the bottom at once, it would be a catastrophe that has never happened in any land engagement that ever was fought; and if you can send three regiments to the bottom by a single shot, that is a thing no land force you ever created, has ever yet or will accomplish. If you can get an army into that condition, it seems to me that that is the situation in which you would most desire to get them, and to fight them when you get them there.

I am extremely obliged to the Institution for the kindness and courtesy with which they have allowed me to come here to learn a great deal from them. Colonel Chesney has been good enough to say he thinks that the discussion has been useful, though not probably in the direction in which I hold it; but still he admits, in an opposite direction. I have always thought, anybody who aspires to take any part in public affairs is bound, when he has his opinions, not to go and deliver them to ignorant audiences, who will believe anything that he says, if he has anything to say, whether it is right or wrong. It appears to me the part of any man who is to do any good to himself or anybody else, is to submit his opinions to the test of those who can confute them, if they are to be confuted; and therefore when I was asked to come here, I felt that I could not in honour and in manliness refuse to come before this Institution, and in the presence of officers of both professions (who could confute anything I have to say), to say what I had got to say; and all I can say is, I have had great pleasure in coming here, and if I have in any way, even contrary to my own opinions, succeeded in throwing light upon this question, the only object I ever had in coming here, has been fully answered.

The CHAIRMAN: I am sure we must all thank Mr. Harcourt for coming forward in answer to the request of our Council; and not only for the able manner in which he has brought the matter before us, giving a good shock to preconceived notions, I have no doubt, on both sides, but also for the extremely courteous and patient manner in which he has carried on his part of the discussion. I must say, I hope that whatever we may think of the legal mind, we shall strive, at all events, in all discussions, in all papers, and at all our meetings, to take a leaf out of his book in these respects.

APPENDIX.

DIMENSIONS OF A SHIP OF 3,464 TONS BURTHEN, PLANNED FOR THE AUSTRALIAN DIRECT COMPANY (VIA PANAMA) OF 1854.

	feet.
Length of keel	326
Fore-rake	8
	334
Beam moulded	45
Depth of hold	32
Tonnage, old measurement	3,306
Tonnage, new measurement	3,464
Engine space	1,022
Tonnage for Custom dues	2,442

Displacement at load-water line, 26 tons per inch.

Estimated Weight.	tons.
Hull	1,600
Spars, sails, rigging	75
Water and stores	350
Engine and boilers	640
Coals	1,500
Cargo, dead weight	837
	5,002

Total weight on board, drawing 21 feet of water from top of keel.

	tons.
Total displacement	5,002
Weight of coals, water, and stores	1,852
	3,150

Being displacement at light-water line 15 feet from top of keel, or 15·9 inches draught of water.

Cargo.	feet.
Contents of forehold	50,874
„ afterhold	37,789
After between decks	17,640
Fore between decks	3,780
	110,083
Deduct space for coals, 1,500 tons	72,000
	38,083

952 tons at 40 cubic feet, being space for cargo alone, exclusive of store, icehouse, &c.

Carrying Capacity.

837 tons dead weight, or 952 tons measurement.
1 ton = 2,240 lbs. = food for 1,000 men, or 100 horses.
100 tons = 224,000 lbs. = „ 100,000 „ 10,000 „
1 ton = 10 mules' burden, or 3 Maltese carts carrying 7 cwt. each.
100 tons = 1,000 „ „ 300 „ „ „

The ship has on each deck 15,000 square feet—
24 square feet is space for 1 horse, or 2 men.
100 „ „ 4 „ 8 „
1,000 „ „ 40 „ 80 „
15,000 „ „ 600 „ 1,200 „

SCREW STEAMER "ADRIATIC" FROM LIVERPOOL TO NEW YORK.

Length	452·6 feet.	Gross tonnage	4250
Breadth	41 ,,	Net register	2950
Depth	32 ,,	Horse-power	600
		Indicator	3000

Superficial area of deck .... 18,532 feet.

The ship is capable of carrying:—

150	saloon passengers
1000	steerage passengers
Total 1150	passengers.

EXTRACT FROM A PAPER ON THE DISEMBARKATION OF TROOPS, BY CAPTAIN SIR W. MENDS, C.B.

The British portion of the expedition to the Crimea consisted of 120 sail, including:—

10 ships of the line (2 being screw steamers).
4 frigates (1 being a screw steamer).
11 steamers of war (paddle and screw).
24 steam transports (including 3 of Her Majesty's).
7 steam tugs.
64 sailing transports.

120 total

The force (British) to be disembarked consisted of—

30,000 infantry.	1,624 horses for guns.
2,192 artillery.	1,530 horses for cavalry.
1,240 cavalry.	65 horses for Staff.
	160 horses for regimental staff.
33,432 men.	3,379 horses.
54 guns.	

Number of boats employed in landing men	326
Number of horse and gun flats	24

The *Allied* flotilla, when at sea, numbered somewhere about 400 sail.

TRANSPORT DEPARTMENT DURING THE SECOND YEAR OF THE CRIMEAN WAR, AS SHEWN BY PARLIAMENTARY RETURNS.

		Tonnage.	Horse power.
Maximum number of steam transports employed..	102	121,060	26,317
Maximum number of sailing ,, ,, ..	115	93,172	
Total	217	214,232	

Number of Officers and men employed in the above, about	9,256
Mean of average tonnage of the steamers	1,196
Mean average tonnage of the sailing vessels	810

Entire means of transport in the Black Sea at the time of invasion, 125 ships, including men-of-war (*vide* Evidence of Vice-Admiral Dundas before Mr. Roebuck's Committee).

Estimate for Transport Service, 1854–55	£3,582,474
Estimate for Transport Service, 1855–56	£5,181,465

Space occupied by Infantry and Horse Artillery on Board Ship.

Infantry.

1 regiment consists of 1,000 men and 17 horses.

1 man occupies 12 square feet; 1,000 men require	12,000	square feet
1 horse occupies 24 square feet; 17 horses require	408	,,
	12,408	,,

Horse Artillery.

Space occupied by—			Super. feet.
1 12-pr. Armstrong gun and limber with the shafts out	14′ × 6′		84
8 horses for ditto, each horse	8′ × 3′ =	24 =	192
			276
1 ammunition waggon	14′ × 6′ =		84
6 horses for ditto	8′ × 3′ =	24 =	144
			228

1 battery consists of—		Square feet.
6 guns, each occupying 276 square feet	=	1,656
6 Officers and 243 men, each man 12 square feet	=	3,000
11 ammunition waggons, each 84 square feet	=	924
11 spare waggons and carts, each 84 square feet	=	924
224 horses, each 24 square feet	=	5,376
		11,880

1 regiment of infantry requires	12,408
1 battery of horse artillery requires	11,880

LECTURE.

Monday, July 8th, 1872.

General Sir WILLIAM J. CODRINGTON, G.C.B., Vice-President, in the Chair.

THE PRACTICAL INSTRUCTION OF STAFF OFFICERS IN FOREIGN ARMIES.

By Captain Frederick G. Burnaby, Royal Horse Guards.

"The art of war" has greatly changed during the last fifty years, and railways and telegraphs have given it quite a different aspect to that which it originally possessed. Topography was formerly but little known; maps were few and far between, not many Officers had the aptitude to read them, and Generals used to trust much more to their guides than to the frequently inaccurate maps then published. Armies are much larger now than they have ever been during the annals of modern warfare, it was formerly so difficult to feed a large army, and railroads did not exist; roads were few and often impassable, supplies were cut short, discontent was the consequence; the army became demoralised, and defeat was inevitable. But if armies are much larger now than they have been during the annals of modern warfare, it must not be forgotten that in the earlier pages of the world's history, enormous forces took the field. Herodotus tells us that Xerxes invaded Greece with an army which exceeded five millions of men, with its combatant and non-combatant strength. But war in those days was not conducted on the same civilised and, comparatively speaking, humane principles as at present. The conquered had to supply the conquerors with every means of subsistence that lay in their country; and those wretched sufferers who were not killed or sold as slaves, had no alternative left but to die of hunger.

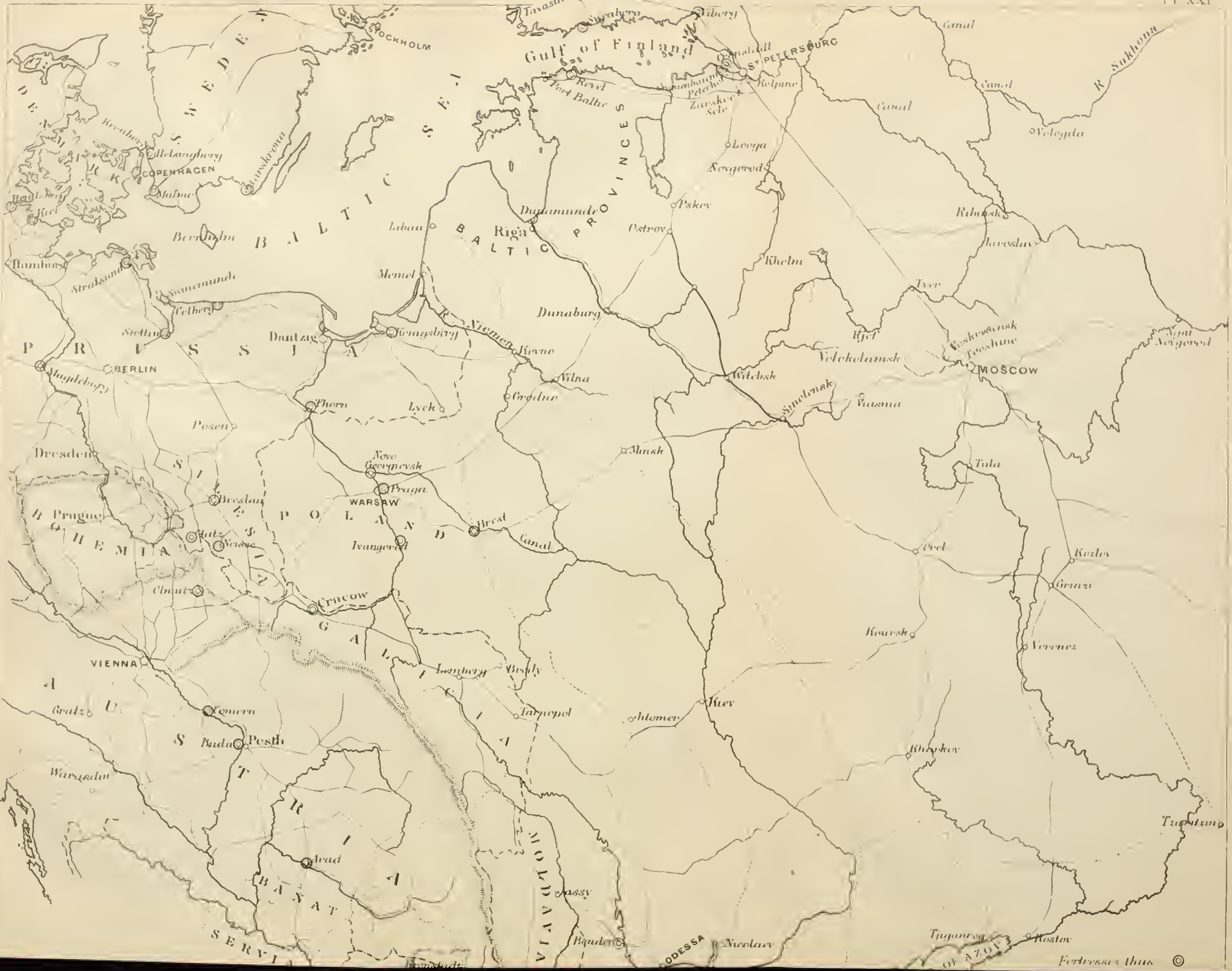
But notwithstanding the exacting manner in which warfare was carried on in those early days, every now and then we read of special instances of large expeditions having their ends entirely frustrated owing to a deficiency in the Commissariat. For instance, Darius, King of Persia, crossed the Bosphorus 513 B.C. on a floating bridge, and led his army of 700,000 men into the country which lies between the Lower Danube and the Don—a country, by the way, which it is interesting to study now, as it may again be the theatre of military events, perhaps sooner than we think. The Scythian retired and carefully avoided battle; Darius pursued; but in those wild steppes there were no means of feeding his army, and eventually he had to beat a retreat. Some historians say that many thousands of his men died of hunger. Again, Alexander of Macedon, on his homeward return from India, divided his forces into three columns. The southern column he sent by ships; the centre one along the coast; and the northern one he led himself through the desert plains of Gedrozia. Here there were no means of feeding his troops, and 80,000 men, or two-thirds of his army, perished, principally from hunger. Again, in later years, General Dumouriez's expedition, at the latter end of the last century, was a failure principally on account of the deficiency of his Commissariat arrangements; and, finally, we have but to look back to the year 1812, and to perhaps the most distinguished General that ever lived, and who had planned his campaign in Russia with the greatest care and forethought. But how disastrously it ended, owing to his army being cut off from its supplies when in an enemy's country.

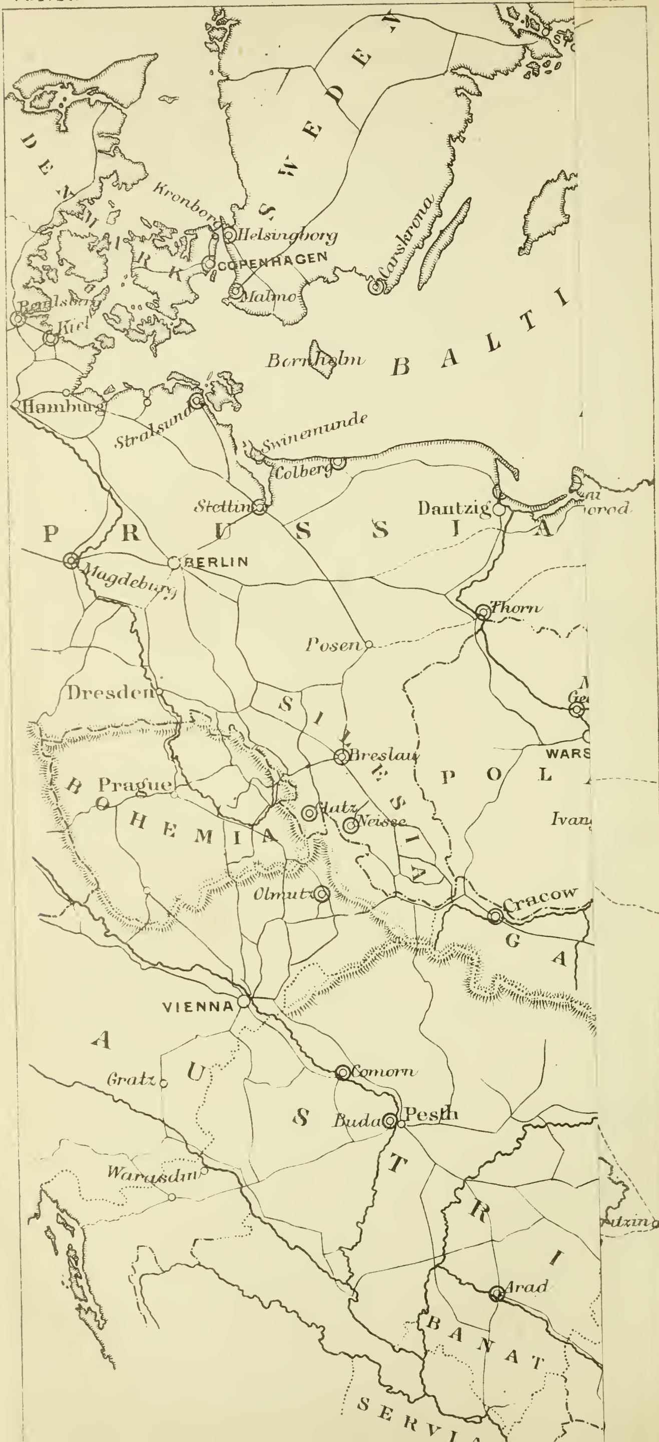
I think I have given you instances enough to prove that in all times and in all ages, one of the greatest difficulties that a General has had to contend against, has been to feed his troops when he has been in an enemy's country.

I now propose to tell you what is done by the Prussian, Russian, and Austrian military authorities to ensure having in their Commissariat, or, as they call it, "Intendance" Department, Officers thoroughly acquainted, both practically and theoretically, with every part of that branch of the profession.

In Prussia, every Officer who wishes to enter the "Intendance" Department has to pass an examination. He has to know all the various divisions of the Prussian Army, and the relation of the separate military commands to the higher civil and military authorities; also the rights and duties of the military administrative depôts with reference to the separate military commands. He has to possess a qualified knowledge of finance, and a thorough knowledge of military economy in times of peace and war. In addition to this, he has to know all statistics relating to the clothing and feeding of an army. No Officer is admitted as a candidate to this examination unless he has served six years with distinction in the regular Army. In some few cases, junior Officers of the Intendance are admitted as candidates; but then they must have shewn special aptitude for their profession, and have served previously in the Line or in the Reserve.

In Russia, the Staff Officers of the "Intendance" have not only to know all the resources of their own country, but they have to know all the resources of every country with which Russia may at any time have to go to war. It is not sufficient for them to know that the country in question is rich, but they must know in what that richness consists, whether in corn or in pasturage, whether in commerce or in manufactures. They must know the network of railways of the country


Tavasthus
Sweaborg
Viborg
STOCKHOLM
Gulf of Finland
Cronstadt
ST PETERSBURG
Reval
Port Baltic
Oranienbaum
Peterhof
Kolpino
Zarskoe Selo
Canal
Canal
Canal
R. Sukhona
Vologda
SWEDEN
DENMARK
Kronborg
Helsingborg
COPENHAGEN
Malmo
Karlskrona
BALTIC SEA
BALTIC PROVINCES
Looga
Novgorod
Pskov
Ostrov
Rendsburg
Kiel
Bornholm
Libau
Riga
Dunamunde
Rybinsk
Yaroslav
Khelm
Hamburg
Stralsund
Swinemunde
Colberg
Memel
Dunaburg
Tver
Rjef
Stettin
Dantzig
Konigsberg
R. Niemen
Kovno
Volokolamsk
Voskresensk
Troitsa
MOSCOW
Nijni Novgorod
PRUSSIA
BERLIN
Magdeburg
Vilna
Grodno
Witebsk
Smolensk
Viasma
Posen
Thorn
Lyck
Minsk
Dresden
SILESIA
Novo Georgievsk
Praga
WARSAW
Breslau
Tula
POLAND
Brest
Canal
Prague
BOHEMIA
Glatz
Neisse
Ivangorod
Orel
Kozlov
Graza
Olmutz
Cracow
GALICIA
Koursk
Voronez
VIENNA
Lemberg
Brody
Kiev
Gratz
AUSTRIA
Comorn
Tarnopol
Jitomer
Buda
Pesth
Kharkov
Warasdin
Tzaritzin
Arad
MOLDAVIA
BANAT
Jassy
SERVIA
Bender
ODESSA
Nicolaev
Taganrog
SEA OF AZOV
Rostov
Kronstadt
Fortresses thus ◎


SWEDEN
DENMARK
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Malmo
Carlskrona
Rendsburg
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POLA
Prague
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BANAT
SERVIA

in question, and in what way they are connected with the Russian railways. They must be able to speak French and German, and be able to state how many Russian troops could be fed in that country in the event of war, by means of "requisition." We read in a very interesting article in the "Voennye Sbornik," or "Russian Military Magazine," a magazine, by the way, in which the articles are written almost entirely by Officers of the Staff, and which is edited by Major-General Menkoff, of the Russian Staff, that Bohemia, which is one of the richest countries in Austria, and which has a population of 5,000 people to the square mile (German mile), would not long be able to support a foreign army, as the richness of Bohemia consists principally in its manufactures, but that in Hungary, Wallachia, or Banat, a foreign army would be able to subsist for a very long time, provided only it had sufficient mills to grind the corn, which is the principal produce of those countries.

The "mill" question is an important one as connected with the Commissariat. The Russians have not forgotten that shortly before the outbreak of hostilities in the Crimea, they had 140,000 quarters of wheat lying in the ports of the sea of Azov ready for shipment to Europe; but this corn was almost all lost to them, owing to their having but very few mills to grind it. We know that Napoleon, previous to his expedition to Moscow, ordered 5,000 hand-mills to be sent with the troops. The order was fulfilled too late, and the mills did not arrive till he was on his retreat from Moscow, and when they arrived, there was nothing for them to grind. Now, if you will follow me through a small calculation, you will see how important the "mill" question is. For instance, let us suppose that Silesia has 2,000 people to the square mile, and that there are mills enough there to grind corn for 3,000. Now, let us presume that an army of 360,000 men is brought to bear upon that country. To grind corn for such a force, it would require that all the mills extending over an area of 120 square miles should be kept going day and night. You can see clearly what a difficulty that would be in the event of war.

The Austrians became so thoroughly aware of their shortcomings in the "Intendance" after the battle of Königgratz, that they determined to start a special military school for all men who wished to acquaint themselves practically with the Commissariat department. And in addition to this they instituted a two years' course of military instruction at the Academy for all Officers who wished to enter the "Intendance." The course of instruction and the system of examination is very similar to what takes place in Prussia. I need not, therefore, detain your attention any more on this subject.

There is yet another element in modern warfare to which great importance is attached on the continent. I allude to railways and to the military carriages for all arms which foreign countries now possess, and, in addition to this, to the military railway commands; and how Officers and men are both practically and theoretically taught everything connected with the railway department. Railways in modern warfare occupy such a very important position as a means of rapidly mobilising and feeding troops, that it is not to be wondered at, that in

Russia—which is a country where the want of railways was so signally felt during the time of the Crimean war—great attention has been paid to this matter. In June, 1869, a special committee of Staff Officers was ordered to sit at St. Petersburgh and to report upon the nature and number of military railway carriages for all arms that every railway company in Russia should be compelled to keep. The result of their deliberations and recommendations was forwarded to the Emperor and signed by him. At present in Russia all the railway companies have to provide a certain number of carriages for wounded, fitted up with litters, and well ventilated; also a number of trucks, specially fitted up with every appliance for the transport of heavy artillery in the event of war; and, in addition to this, a large number of horse-boxes or horse-trucks; and there seems to be a very useful device in connection with them, for they are so contrived that the sides of the trucks can be let down and formed into a bridge, so that the cavalry can be got out at any point on the line without waiting for their arrival at a station. The railway companies have also to provide a large quantity of carriages fitted up with racks and every sort of contrivance for hanging up soldiers' knapsacks and arms. At present in Russia they have enough of these carriages to transport 54,000 infantry, 1,500 cavalry, a proportionate quantity of artillery, 1,464 slightly wounded, and 732 severely wounded men; and the railway companies are still constructing more of these carriages.

In imitation of the Prussian military "railway commands," which proved of such signal use during the Austro-Prussian war, the Russians determined to institute a force of their own, founded on the same model. For this purpose they dispatched 432 men and 8 Officers to all the different railways in Russia. This was three years ago. The men had to learn both practically and theoretically everything connected with the management of the line, and the Officers were ordered specially to study the duties of station-masters. In June last year it was thought by the military authorities at St. Petersburgh that it would be a very useful thing to ascertain in some manner the exact amount of knowledge which every Officer and man had attained in his new calling. For this purpose it appeared that the best possible means would be to construct a railway during the manœuvres. This was determined upon, and it was resolved to unite the Peterhof and Warsaw lines, and make a branch from the Ligovo station to the ninth verst of the Warsaw line. This line, if left standing, would be very useful as a means of connecting Peterhof with Tsarskoe and Krasnoe Selo; and if prolonged as far as Kolpino, on the Nicolaieff line, it would facilitate communication with Oranienbaum, where it had been proposed to construct a port. This Nicolaieff has nothing to do with the Nicolaieff near Odessa, but the railway is called Nicolaieff because the Emperor Nicholas was the person who ordered its construction, and it was the first line laid down in Russia. Major-General Annenkoff, of the head-quarters' staff, was requested to take command and to make all the necessary arrangements. The men and Officers who had been sent to the different lines were telegraphed for to come to St. Petersburgh, and on their arrival they were formed into two companies of 216 men and 4 Officers in each company. In the companies there were engineers, engine-drivers, stokers, guards, constructors of trains, pointsmen, signal-men. The 22nd infantry division and one reserve engineer battalion were ordered to assist in the work. The whole length of the line, I should have told you before, was eight versts, or seven miles. The work was commenced on the 28th of July, and it was finished on the 4th of August. There were two stations constructed, one at each end of the line, and ten bridges, one over the Ligors Canal, which is there more than 50 yards broad. The Emperor was so pleased with the celerity with which the work had been performed that he was determined it should be left as a permanency. The entire expense of it to the country was 150,000 roubles, or a little more than £21,000, and it is said that the Government will not be a loser by the transaction, for the exploiting of the line will thoroughly pay for its cost. Russia is more dependent upon these military railway commands than perhaps any other nation, because almost all the men who are working on the line from Vilna to St. Petersburgh are either Poles or Germans, and in the event of war, it would be necessary to replace them with Russians. For this reason Russia has more reason to be particular about these matters than either Prussia or Austria.

There is, however, yet another military element, which I am now going to speak to you about. This element in warfare is perhaps the most important one of all; for no matter how well a campaign may be planned, no matter how skilful the General who plans it, if his subordinates during the time of war do not properly execute their independent trusts, signal disaster is sure to take place. I allude to "strategy." For let us imagine that a country has an army, that that army has its railway commands in the highest possible degree of efficiency, and that its Commissariat is perfect; let us further suppose that that army is well clothed, well armed, and well disciplined. Still, the nation which possesses such a force cannot even then be assured that it has a trusty defence in the moment of danger; for it is necessary to give all armies in time of peace a thoroughly warlike education. Sad will be the fate of those forces whose leaders think that the moment of commencing hostilities is the moment for commencing, and not for terminating, their military education. Bravery and superhuman exertions will not compensate for the want of strategy in modern battles. The "Kriegs Spiel," or war game, is an admirable means of theoretically studying the art of war in time of peace. It may be made most useful as a method of studying tactics and learning the ground over which double manœuvres, or what we call "autumn manœuvres," are to take place. But where Prussian and Russian Officers find the "Kriegs Spiel" of such advantage is, that they are enabled by it to play the game over a foreign country, where they have no opportunity of manœuvring their troops until actual warfare commences.

In England the "Kriegs Spiel" has to be played with the 6-inch map; for the Ordnance survey 1-inch map is too small; and while I am on the subject of maps, and as maps play such an important part in modern warfare, perhaps I may be allowed to make a few remarks with reference to our own Ordnance survey. The English

Ordnance survey map, as far as its trigonometrical lines go, is perhaps the most accurate one that has ever been published; in fact it is so accurate that I remember last year Captain Moncrieff, the inventor of the celebrated gun carriage that bears his name, saying that he believed it would be possible in the event of war and of a foreign foe being on our shores, to place a battery of guns behind a hill, and then to send out an Officer to mark down the exact point where the enemy were, and if they were not more than a mile off, he would be able, without seeing the enemy, to shell them from their position, and by means of the map, direct his guns and make the shells fall into a piece of ground not larger than 100 yards square. But if the English Ordnance survey map is so wonderfully accurate as far as its trigonometrical lines go, it must not be forgotten that it is a very old survey, and does not represent the present actual condition of the country. A country changes very much. Roads are turned, roads are altered, fresh roads are made. What was marsh is now cultivated ground; what were woods may be arable country; and what were arable grounds may now be woods. If we take the Ordnance survey map of England and draw a line from Essex to Glamorgan, and again from Cornwall to Kent, we find that the intermediate country was surveyed in 1816. Since then the railways have been inserted; but the roads remain in exactly the same state on the Ordnance survey map as they did in that year. Again, if I turn to sheet 8, counties of Surrey and Hampshire, I see that this map was published also in 1816. Since then the railroads have been put in, and the camp at Aldershot; but the roads five miles from the camp remain exactly in the same state on that map as they did fifty-six years ago. It is true we have the 25-inch parochial scale map, but this is a partial map, and not the Ordnance survey. I cannot help thinking if the "Kriegs Spiel" could be played on a raised or modelled map, showing the height of the hills and the ridges, it would be a great advantage, especially to artillery Officers.

Double manœuvres, or what we call "autumn manœuvres," are undoubtedly the best means in the world, short of actual warfare, for teaching Generals strategy, provided that the number of men employed on both sides is sufficiently great to make their handling as intricate a matter to the Officers concerned, as it would be in actual warfare. But manœuvres are costly things. Again, in England they can only take place once a year, on account of our climate and our agricultural conditions; and in some counties they cannot take place at all without great opposition being made to them by the game and landed proprietors. Now, in the event of war, and of Mr. Vernon Harcourt's theory proving incorrect, we cannot expect our enemy to ask our opinion as to which should be the best route for him to move upon London. It is, therefore, advisable that the closer and confined counties should be as well known to our Staff Officers, as the more open expanses of country, which are in England, alas! becoming each year more scarce. Again, double manœuvres, though admirable practice for Generals, are not so beneficial to Colonels, particularly to junior Colonels, who only command their own battalions; because these Officers have exactly the same command in the "autumn manœuvres" as they would have in their own barrack field. In addition to this, on returning to camp each evening, they have their time so thoroughly occupied with the care and management of their horses and men, that they have but very few moments left to consider what have been the tactical problems of the day. Now the very men who are now Colonels commanding regiments, in all probability in the course of a few years—or, if war should take place, much more quickly—may be Generals, and then we might see the strange anomaly in the nineteenth century, of Officers placed in positions of high responsibility, who had not been sufficiently prepared for them in time of peace.

The Russian military authorities have long had their attention drawn to this question. They saw plainly that their autumn manœuvres would only be a source of useful instruction to the senior Colonels and Generals; it was therefore determined to institute some means of practically teaching their junior Colonels and other Field Officers the higher commands in warfare. For this purpose they resolved to send out parties of Staff and Field Officers from every military district into which Russia is divided, to divide each party into two sides, and to let them manœuvre against each other exactly in the same way as they would during the grand manœuvres, but with this difference, that the armies, divisions, and brigades should be skeleton ones, and that two or more infantry men should represent an infantry regiment, two or more cavalry men a cavalry regiment, and a gunner a gun or a battery, as the case might be. Two similar expeditions were sent out from the head-quarter Staff of St. Petersburgh in the spring of last year, and three others were sent out from Moscow, Kiev, and the Warsaw districts in the autumn. My present object is to tell you what was done by the party of Officers who were sent out in the Moscow district.

Before I commence, however, I must tell you that the subject of manœuvres is naturally a dry one, and full of details; but I will endeavour to make them as clear and interesting as possible by means of this large military sketch. It is taken from a Russian military map which was drawn out by a Colonel of the Russian Staff. This rough military sketch shows all the fortresses in Russia, and it also shows the railroads, and their connection with the Austrian and Prussian railroads. I know that many people in England look upon a war between Prussia and Austria against Russia as a great improbability, but I can assure you that Prussian and Austrian Staff Officers do not think so. I have often heard people in England say, "Ah, but remember the friendly "relations that exist between the two countries; and look how well "Prince Frederick of Prussia and General Moltke were received at St. Petersburgh last year." Did family connection preserve his throne to the poor King of Hanover? and was the reception given by the Emperor Napoleon to the King of Prussia a few years ago one whit less hospitable than that shown by the Russians to the Prussian Prince and to General Moltke. There is a great deal of difference between saying what you think, and thinking what you say. Do you think Napoleon said what he thought to the King of Prussia, when he paraded his Imperial Guard before him in Paris? And was not King

William himself, perhaps, an example, a living example of the old adage or saying attributed to the celebrated French philosopher, that "words were given to man to disguise his thoughts."

I remember hearing an admirable speech made two years ago in the House of Commons. The orator, after alluding to the causes which led to the Franco-Prussian war, said, no man in Europe who has carefully followed the course of political events during the last few years, could have failed to observe that after the battle of Sadowa, there was a train of gunpowder laid from Berlin to Paris, which only required the spark to set Europe in a state of conflagration. It is the opinion of many people in Prussia and Russia, amongst whom are Officers and persons whose opinion is well worth having, that after the battle of Sedan there was a train of gunpowder laid from Berlin to St. Petersburgh, which only requires the death of one aged monarch to kindle not only Europe, but also part of Asia in one general bonfire. I know some people in England think that we have reason to apprehend Russia in India. This is a question which, though now like a cloud no bigger than a man's hand, will as certainly loom up in the far-off future, as that the Southern States of America will at some distant period again try to cast off the hated yoke of the Northerners.

But you may ask me why should Austria be dragged into this war? If Prussia and Russia go to war, nominally on account of the Baltic provinces, but in reality and as is the case in most wars for the sake of statesmen's ambition, and for the desire inherent among nations as amongst men, to determine which is to be the master, it would be far more disadvantageous for Austria to remain neutral than to throw her sword into the same balance as an ally with her late foe. Poor Austria! the Kaiser who rules her heterogeneous empire has a difficult task to perform in endeavouring to govern a variety of nationalities, who all want to govern themselves; and in the event of victory or in the event of defeat, Austria's lot will be equally an unenviable one. Her eight million Germans, and sixteen million Sclaves and their territory are as tempting a morsel in the eyes of Prussia and Russia as Naboth's vineyard was to the Jewish King.

But I must return to the manœuvres, and I will now tell you what was done by the party of Officers which went out in the Moscow district. It consisted of 2 Generals, 16 Staff Officers, 29 Field Officers, 2 Officers of the Intendance, and 3 medical men; 75 infantry soldiers, 60 cavalry soldiers, and 28 artillerymen, were ordered to join the expedition to act as markers; and 120 horses were attached to it for the use of the Officers during their exercise in the field. The following was the plan of the manœuvres:—A western army, evidently a Prussian one, has crossed the River Niemen between Kovno and Grodno. I should here tell you that the Russians intend to build a fortress at Kovno. They have all the plans drawn out for it, but the works are not yet commenced. Well, this army has crossed the River Niemen, between Kovno and Grodno, has invested Dunaburg, and occupied Pskov, and from Looga it marches on St. Petersburgh. A southern army, probably an Austrian army, in alliance with the western one, has occupied Jitomir, and from Jitomir marches on Kiev. A detached force of the western army, after the occupation of Pskov, receives orders to march forward and clear the line of operations for the main body, and then to march on through Rjeff to Volokolamsk, and thence to Moscow, if possible to occupy Moscow, and to prevent the formation of reserves for the eastern army, which was defeated at a battle supposed to have taken place when the western army crossed the River Niemen between Kovno and Grodno.

The Officers having been divided into two sides, one side was assumed to represent the party marching from Pskov on to Moscow, and the other was supposed to be a detached force of the eastern army stationed at Voskresensk, with the view of impeding the attempt of the western army to take Moscow. This was the plan of campaign. The assumed strength of each of these detached forces was three divisions of infantry, eight regiments of cavalry, and a proportionate quantity of artillery, one engineer battalion, one pontoon half battalion, and a railway command. The colonel of an infantry regiment was to command one side, and the colonel of a cavalry regiment the other. Previous to commencing their operations, the Officers on both sides had to go through a preliminary course of instruction. The Officers of the western army had to study the military topographical description of the road between Pskov and Moscow, and had to give a detailed account of the railroads, roads, and other means of communication. They had to ascertain the numerical strength of every division in their assumed army with reference to existing statistics, and to state the best manner of forwarding troops through Pskov and Ostrov to Volokolamsk. They had also to send in reports upon the best means of covering their front during their march, and of keeping up their line of communications, and to state where it would be most advisable to leave depôts, and the quantity of men that it would be necessary to leave at each depôt for its defence. The Officers of the "Intendance" had to study the nature of the country through which the expedition would have to pass, and to report in what districts they would be able to provide the troops with provisions by means of requisition, and in what districts they would be compelled to use transport. The Officers of the artillery had to give a detailed account of the exact amount of ammunition assumed to be with the Force and in store, and also of the best means of forwarding stores. The Officers of the medical department had to inform themselves as to the formation and construction of military hospitals, and the furnishing them with every requisite. The Officers of the eastern army had to study the military topographical description of the Moscow, Kiev, and Smolensk districts, and in addition to this, they had to draw up a plan for the fortification of Moscow. By this plan it was proposed to fortify Moscow on the western side, to throw up thirteen earthworks, and to place in an efficient state of defence the cemetery and large buildings outside the town. It was calculated by this plan that 10,000 men would be required to defend the fortifications, and that those fortifications would be able to shelter an army of 100,000 men. The Officers of the Intendance had to report upon the best means of providing Moscow with provisions for the space of ten months, and also upon the best method of despatching supplies to the troops when they were engaged in the field. The Officers of the railway command had to report upon the time required and best means of forwarding an infantry division from Nijni Novgorod to Moscow, and a cavalry brigade from St. Petersburgh to Moscow.

As the conclusion of these preliminary tasks, the commanding Officers on both sides gave their Officers instructions that, during the operations in the field, they would have to make reconnoissances, to prepare routes for marches, to select the best place for camps, bivouacs, &c., to arrange expeditions for foraging, and also from time to time to draw up their men in battle order, and to report upon the best means of fortifying the positions taken up by them by the means of field works, and to give a detailed account of the number of men, and the time that would be employed in throwing up each field work.

With the solution of each tactical problem the Officer would have to furnish a map of the locality, and also a written statement showing the disposition of his troops; and, previous to an assumed assault, a survey would have to be made of all approaches to the position. The Commander-in-Chief of the Moscow district was to be the head umpire. He was to have charge of both sides, and to be assisted by eight senior Officers, who were to aid him in verifying the tasks performed by the Officers in the field. The military medical inspector at Moscow had to verify the work done by the medical men attached to the expedition. A day was allowed for the solution of each more complicated problem; and all the Officers had to keep diaries in which everything they had done in a military sense during the day had to be noted down, and a printed journal was kept on both sides stating the progress of the day's marches, and the course of the manœuvres.

Every morning at 12 o'clock the head umpire sent to the Commander-in-Chief on each side, information as to the enemy, and according to this information they had to make their arrangements and all dispositions, and forward the same in writing to the head umpire, at the same time telling him what had been the tasks performed by the Officers under their command the day before. The head umpire on receiving this information sent back word when, and where, and by whom the tasks would be verified. If the two sides approached so closely that a collision appeared inevitable, the head umpire desired the Commanders-in-Chief on both sides to make all arrangements exactly the same as they would during actual warfare, and that they were to mark out the ground chosen by them by means of the men with flags. During the course of the engagement, the different umpires rode about, and informed the various division leaders and brigade leaders of what was being done by the division leaders and brigade leaders on the opposite side, and according to this information, the division leaders and the Brigadiers had to act. If they changed their position they had to make a rough sketch of the place, and to state how they had disposed of their men. If an infantry regiment had to attack, the commander of the infantry regiment had to design a map, and state exactly the nature of the ground, and how he would have led his men to the assault without exposing them too much to the enemy's fire; or, in case of resisting an assault, how he would have availed himself of the nature of the ground in the locality. Every order during the manœuvres was sent in writing; for it had been found during the autumn manœuvres at St. Petersburgh, that very often mistakes had arisen. In time of war we know what disastrous consequences may ensue through any error in a message. During these "skeleton manœuvres" every order was sent in writing, and these orders had to be kept for the inspection of the umpire at the end of the day, so that should any mistake arise, the umpire might be able to see whose fault it was, and whether the fault lay with the Officer who sent the order, and who had not worded it properly, or whether the fault lay with the receiver of the message, who had shown a dearth of comprehension. A certain quantity of young Officers were also attached to the expedition to act as "gallopers," to convey messages. They from time to time received written orders for the different division or brigade leaders, with the exact time marked upon the envelope. When they had received them, they then had to ride perhaps six or seven miles, and find their way by means of a map to the person to whom the order was addressed. When he received it, he marked down the exact hour; and the following day the head umpire compared the two times, when it was clearly ascertained whether the Officer had carried the message with due and proper celerity. In addition to this, the Officer who carried the message had to make a rough sketch of the ground over which he had galloped, and to give an account of the nature of the country. The day after a battle, the head-umpire rode over the battle ground with all the Officers' maps and plans, and compared one with the other, and pointed out the mistakes which ought not to have been made, or approved, if he thought it right to do so.

Twenty-one days in all were allotted to these manœuvres; seven days were devoted to preliminary instruction, seven days were allotted to work in the field, and seven days to verifying the problems and tasks performed by the Officers. The following were the tasks that were performed by Officers in the field:—The Officers of the western army fought a battle at Voskresensk, then from that place they made a flank march on the Smolensk high road, and fought three retreating battles as far as Viazma. The Officers of the eastern army fought a battle at Voskresensk, then they made a retreat march to Tooshino and Kinsk, and thence an advance, with three battles, along the Smolensk high road.

At the conclusion of the manœuvres, the Officers of artillery sent in reports to the military authorities, how they would have supplied the forces under their command with ammunition after the battle at Voskresensk. The Officers of "Intendance" reported upon the means they would have employed to remove their baggage when they made their retreat. The medical men also sent in reports as to how they would have supplied their hospitals with every requisite, and how they would have forwarded the wounded to Moscow and Viazma. The other Officers sent in a report of the survey they had made of the River Moskva, and the River Istra. At the conclusion of the manœuvres in the three districts, the chief umpire on each side sent in a detailed report to St.

Petersburgh, and these reports were submitted to the inspection of a board composed of the senior Generals in the Russian army. These Officers, after carefully reading the various remarks, came to the conclusion that these manœuvres are most useful. In the first place, they cost the country very little; secondly, in an enclosed and confined district you can manœuvre with freedom, and without doing any damage to the crops; and, thirdly, you give the opportunity to Colonels and other Field Officers who do not command brigades, during the autumn manœuvres, to command brigades and divisions, and learn the higher commands in warfare. It was resolved that these "skeleton manœuvres" should take place in every military district in Russia, certainly once, if not twice, a year; but that first of all the direction of the manœuvres should be specially confined to the western frontier.

From the various subjects I have brought before you to-day, it would be very easy to make deductions, and possibly to draw comparisons. But if I were to do so it might be misconstrued into an attempt at criticism, so I shall leave it for Officers who are older and far wiser than myself to consider whether any of the systems I have mentioned this afternoon might be beneficial if adopted into our own service.

The CHAIRMAN: I will now ask you to thank the lecturer very much for his kindness in giving a lecture which I am sure is replete with interest, which will interest those who may read it in print, as well as those who have been present to-day.

ERRATUM.

Under the title of "Campbell's Range Indicator," at page 311, vol. xvi, 2nd line from the bottom, *for* "$d\,Z$ produced is an asymptote to the curve," *read* "$d\,Z$ produced is parallel to an asymptote to the curve, the distance between the two lines being $= 120\,h$."

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LECTURE.

Friday, May 24, 1872.

VICE-ADMIRAL A. P. RYDER, in the Chair.

ON COAST FOG-SIGNALS.

By ALEXANDER BEAZELEY, M. INST. C.E.

IN the course of discussion on a paper "On the Loss of Life at Sea," read before this Institution in May 1866,* Admiral Halsted thus graphically described the case of those who have "the anxiety of "navigating a ship in our narrow waters, in our foggy and dark "climate. You come in from sea, not having had observations for "three or four days, you take soundings in the channels; but where "on earth you are, you do not know, and your only chance of correctly "knowing where you are when knocking about in the fluctuations and "changes of the tide, is to get well in with some well-known spot of "land; and the safest spot which you can get in with, under these "circumstances, is some danger light. If it is thick weather, you are "bound to run in to some light until you make it. After you run in "a certain distance, you know by your soundings that you are nearing "the land, and you go creeping on like a moth round a candle till you "strike upon the rocks round the danger light, which is erected for "your safety." I have quoted these words at length, because it is precisely under the circumstances which they describe that the service to be performed by Coast Fog-signals commences. When we consider the frequency of the occurrence of foggy and other thick weather on our coasts, and the vast numbers of vessels, engaged in coasting or over-sea traffic, which require a warning or guide during such weather, the immense importance of these signals becomes apparent; and it is surprizing how slight and superficial is the knowledge in this country respecting them, and how limited their practical application.

The subject of Fog-signals divides naturally into two branches; one relating to the means employed on board of ships, for the purpose either of giving warning of their whereabouts to other vessels, or of communicating intelligence or orders; the other to those employed at fixed stations on or near the coast, to serve as guides to navigation, in which respect they are to be regarded as fulfilling the same purpose as lights, at times when daylight or atmospheric obstruction renders the lights useless. The former division of the subject, relating to what may be specially termed Marine Fog-signals,* has been treated-of in Captain Brent's very interesting paper already before this Institution, and will doubtless continue to receive at the hands of naval officers that further investigation which its importance undoubtedly deserves. It is the latter division of the subject, relating particularly to Coast Fog-signals, to which I propose to invite your attention on the present occasion, although most of the instruments to be treated-of are common to both.

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* Journal R. U. S. Inst., vol. x., p. 225.

These instruments are, gongs, bells, guns, trumpets, whistles, and syrens. I shall proceed to consider each instrument separately, in order to clear the way for a consideration of the whole subject in a general manner.

Gongs.

Gongs are used on board light-vessels, and are struck by hand with a stick having a padded head. With reference to this practice, I am informed that in the East they are sounded by rubbing, which is commenced at the centre, the diameter of the circle of friction being gradually increased until the maximum sound is elicited; and it is said that a much greater volume of sound is produced by this means than by striking, whilst the risk of injury to the gong is of course diminished. How far this instrument can be heard in fog, or during thick or snowy weather, is not known. M. Reynaud, whose experience and care as an observer entitle his opinion to great weight, states that its range scarcely exceeds 550 yards—meaning probably its mean effective range. Gongs have been heard at a greater distance, but probably under exceptional and favourable circumstances. Their use ought unquestionably to be restricted to that of guides to the navigation of short channels, harbours, and similar situations, where great range would be useless; and they should never under any circumstances be depended-upon as sea-signals where great range is requisite.

Bells.

Bells are extensively used as fog-signals, and their employment for this purpose dates from a remote period. Those at present in use vary much in weight, ranging from 3 cwt. to upwards of 2 tons.

The experiments made in France in 1861—62 by the engineers of the Corps des Ponts et Chaussées afforded some valuable practical information upon the subject of the striking of bells. It was ascertained that the range of their sound increases with the rapidity of the strokes, the relative distances for 15, 25, and 60 strokes per minute being in the ratio of 1, 1·14, and 1·29. Experiments were also made respecting the effect of a hemispherical iron reflector, backed with Portland cement, in increasing the range of a bell, and it was ascertained that the use of such a reflector increased the mean range in the ratio of

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* Journal, vol. xv, page 136 *et seq.*

147: 100 over a horizontal arc of 60°, beyond which its effect gradually diminished.

In the Admiralty notification of the fog-bell at Whales Back, New Hampshire, it is stated that it should be heard at a distance of from a quarter of a mile to four miles, according to circumstances. But this is only an estimate. Respecting the range of a bell during fog, as ascertained from actual observation, I have been unable to discover any reliable evidence, save in two instances quoted by Mr. Cuningham, Secretary to the Commissioners of Northern Lights, in a Paper on Fog-signals.* It is therein stated, that a bell at Howth, weighing $2\frac{1}{4}$ tons, struck 4 times per minute by a 60-lb. hammer falling 10 inches, has been heard only 1 mile to windward against a light breeze during fog; and that a similar bell at Kingstown, struck 8 times per minute, has been heard at a distance of 3 miles so as to be useful to a steamer, enabling her to make the harbour from that distance. In the latter instance it is probable, either that there was no wind, or that the steamer was to leeward. But it is to be remembered that those two bells are unusually large, in fact they and the one at Ballycottin are the largest on our coasts, the only others which at all approach them in weight being those at Start Point and South Stack, weighing respectively $31\frac{3}{4}$ cwt. and $41\frac{1}{2}$ cwt. If, then, a bell of that great size is efficient, against a light breeze, to a range of only 1 mile, what, under similar circumstances, may be expected to be the range of the comparatively light bells of from 3 to 7 cwt. employed as fog-signals at our rock lighthouses, which are outlying danger stations? In the paper above mentioned, speaking of the fog-bells at the Bell Rock and Skerryvore with reference to such a signal at rock lighthouses generally, Mr. Cuningham says—"It is the only one which seems to "be suitable for such localities, but its efficacy seems to me, in the "present state of our information, to be very doubtful. I doubt if "either bell has been the means of saving a single vessel from ship-"wreck during fog. I cannot recall . . . . any instance of a vessel "reporting that she was warned to put about in fog, or that she ascer-"tained her position in any respect by hearing the sound of the bell in "either locality, though it is quite possible that such instances may "exist."

In the case of a rock lighthouse, there is another important circumstance to be taken into account:—Owing to the situation of most of these structures, they are exposed during stormy weather to very heavy seas, which run green water up the shaft of the tower and not unfrequently fly clean over the gallery-course. The bell is usually suspended from cantilevers at or about the level of the gallery-course, and would, if placed on the most exposed side of the building, be liable to be carried away—a thing which actually occurred in 1860 at the Bishop Rock—and it is therefore placed on the most sheltered side. Hence it follows that its sound is intercepted and deadened by the tower towards the most exposed quarter, generally the seaward side, where it is most required to be heard.

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* February, 1863. Trans. Roy. Scottish Soc. of Arts, vol. vi.

Guns.

The range of the sound of cannon is commonly supposed to be very great, and there are on record well-authenticated cases in which artillery has been heard at a surprizing distance. It would therefore seem natural to infer that cannon must be serviceable as a fog-signal. That they are so in many instances is not to be denied. Admiral Sir A. Milne informs me that he has often gone into Halifax harbour, in a dense fog like a wall, by the sound of the Sambro fog-gun. This is a fair test of efficiency. Still, there are some considerations tending to show that implicit reliance ought not to be placed on the efficiency of guns in all cases. In the first place it is to be remembered that we are apt to be strongly impressed by exceptional and startling results, and to overlook the very much larger number of instances in which the results are comparatively trifling. In the next place, it is a well-established fact that even in calm and clear weather the range of the sound of guns is extremely variable. In the Trinity House experiments off Dungeness, in January 1864,[*] made in fine weather, with calms and light airs, the report of an 18-pounder with 3 lbs. of powder was faint at 4 miles. In those of 1865[†], made in similar weather with the same description of gun, the report was distinctly audible at 7 miles. And Dr. Gladstone[‡] has recorded the remarkable irregularity of the noise of a gun in some experiments at Holyhead. It is unnecessary to multiply examples of a phenomenon which must be familiar to all who have had much experience. Such being the case during calm weather and in the absence of fog, it needs no great amount of reflection to perceive that, during fog, even in the absence of wind, the probability of irregularity and uncertainty is greatly increased. The report of guns fired at sea as signals of distress can frequently be heard on shore, at a considerable distance, and during very thick weather and through the roar of breakers; but signals under these circumstances are generally made to windward of the hearers.

There is a practical disadvantage in the use of a gun at or close to a lighthouse, in the effect of the concussion upon the building and apparatus. I am informed by the Rev. Dr. Robinson, F.R.S., that the glass of the Duncannon lighthouse was generally shattered when the 68-pounders in a battery close by were fired in target practice. The same thing occurred frequently at the lighthouse on Staten Island.[§] A similar result might be produced by a fog-gun, and, if it took place at night, would be an extremely serious matter, involving perhaps the extinction of the light.

The three fog-guns on the English coast are iron 18-pounders, with a charge of 3 lbs. of powder, and are fired at intervals of 15 minutes. The gun at Rathlin Island, having a similar calibre and charge, is fired every 20 minutes. Brass guns would probably be more efficient as a signal than iron ones, as they give a much sharper report; but they would cost more in the first instance.

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[*] Parliamentary Paper, 1864. Commons, No. 125.

[†] T. Stevenson, "Lighthouse Illumination," 2nd ed., p. 198.

[‡] Proceedings Royal Institution, vol. iv., p. 54.

[§] Report of U. S. Lighthouse Board, 1871, p. 20.

The average duration of fogs at the English gun-stations is nearly 6 hours, and they not unfrequently last 20 hours at a stretch. Even with two gunners, therefore, the efficient service of the gun entails very severe labour, and the risk of remissness and irregularity must be considerable.

The first cost of a fog-gun establishment will vary according to locality and other causes, but it may be roundly assumed to be £1,000, including two 18-pounder guns, and all the necessary buildings on a moderate scale. The average working expense of the English gun-signals, including wages, allowances, stores, and ammunition, is at the rate of £18 1*s.* 10*d.* per 24 hours of work.

Trumpets.

At the risk of appearing somewhat inconsistent with my design of treating exclusively of fog-signals for coast purposes, I must refer briefly to one intended for use on board ship, because it is apparently the earliest example of the application of machinery to the blowing of fog-trumpets. This was the "Telephone" of the late Admiral J. N. Tayler, submitted to the Admiralty in 1844. The sound was produced by pipes, having metallic reeds, and blown by air condensed into a receiver by means of air-pumps worked by a winch and cranked axle. It was estimated by the inventor, that this instrument would have an effective range of 6 or 8 miles in foggy weather, and that by means of a parabolic reflector a still greater range could be attained. Whether these expectations were fulfilled, I cannot say, having been unable to discover any report upon the experiments which it is believed were tried; but it is important to observe that we have here the metallic reed, and the compression of air by machinery. Admiral Tayler stated that his attention was first called to the adaptation of this instrument for the purpose of marine communications by an Alarm which he heard in France. M. Reynaud, to whom I mentioned this circumstance, has endeavoured to discover some trace of the latter apparatus, but without success.

The metallic reed, and the use of air condensed by machinery, re-appear in the fog-trumpet invented by an American gentleman, the late Mr. C. L. Daboll; and his apparatus, erected in 1851 at Beavertail Point, R. I., by the United States Government, affords the earliest example of its actual employment in practice. The machinery, which was moved by a horse, was very simple, and was applied to the revolution of a cranked axle driving two 3-inch air-pumps. The condensed air was stored in a 225-gallon receiver, on which was fixed the trumpet, and the air was admitted to the reed by a valve regulated by a cord and lever. The initial pressure at which the trumpet was sounded was about 40 or 50 lbs. per square inch. The recorded performances of this apparatus* are surprizingly good. During dense fog and against a light breeze, it was heard distinctly at a distance of 6 miles on shore; and Captain Walden, U. S. Revenue Service, who officially examined and reported upon it, heard it distinctly at 2½ miles, in a rough sea, with a strong cross wind. The practical value of this instrument was promptly recognized by the U. S. Government, and no time was lost in erecting similar ones at different points on the coast. Improvements in details were at various times introduced by Mr. Daboll: the action of the valve regulating the duration of the blast was made automatic; the trumpet was made to revolve automatically, so as to distribute the sound over any required arc; the use of wires or rods was introduced, as a means of opening and shutting the valve when want of space or other circumstances necessitated the placing of the trumpet at a distance from the condensing apparatus; and engine-power was substituted for horse-power to drive the machinery. These matters formed the subject of a patent taken out by the inventor in 1860 in the United States, and in 1863 in this country.

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* Report of the United States Lighthouse Board, 1852.

In a Paper read last year before the Institution of Civil Engineers,* I stated that Daboll's trumpet was not constructed to vibrate in unison with its reed, but acted merely as a condenser and conductor of the sound. Some months after that Paper was read and printed, I met with a Report of the United States Lighthouse Board,† in which distinct mention is made of the tuning of the reed in unison with the trumpet. Whether the instrument was originally so designed, is quite immaterial, few if any inventions being produced in the first instance in such perfection as to be susceptible of no improvement. But it is of importance that the correction should be made in as public a manner as the mis-statement, not merely for the sake of accuracy, but also in justice to the memory of Mr. Daboll, whose name is so honourably associated with the first application of the trumpet to practical use as a fog-signal.

Daboll's trumpets are classified according to size, those in most general use being of the second and third order, which are respectively of the following dimensions :—Axial length, 9 ft. and 4 ft. 6 in. Diameter at small end, 2¾ in. and 2½ in. Diameter across mouth, 2 ft. and 1 ft. 9 in.

In 1865 a second-order Daboll's trumpet was established at Dungeness by the Trinity House of London. A third-order experimental one which had previously been set up there, but had not been notified for use as a fog-signal, was placed on board the Newarp light-vessel in 1868, where it is now sounded during fog. In 1868 a second-order one was established at St. Catherine's. The Newarp trumpet is sounded at an initial pressure of about 12 lbs. and a terminal pressure of about 9 lbs., those at Dungeness and St. Catherine's at an initial pressure of 20 lbs. and a terminal pressure of about 5 lbs. I am not aware of any observations being made, or any record kept, of the range of their sound during fogs. It is said that the Newarp trumpet can be heard at 5½ miles distance, during foggy weather and against a light air, but not during very dense fog or against a moderate breeze.

In 1866 a Daboll trumpet of the third order was established at the mouth of the Clyde by the Cumbrae Lighthouse Trust. For the following particulars relating to this fog-signal I am indebted to Mr. Graham, the Treasurer and Superintendent to the Trustees. A Report from the keeper mentions two instances, out of many which have been prominently brought under his own observation, of the valuable services it has rendered to navigation:—" A steamer, whose captain was well " acquainted with the navigation of the channel [of the Firth of Clyde], " in coming in from sea was enveloped in fog in good daylight, and got " so completely bewildered that he ran up on the west side of Bute, as " if he had intended to proceed up Loch Fine; immediately on the horn " starting he recognised his mistake, put his steamer about, and headed " direct up under the fog-signal house. The second instance was in " the case of a schooner, whose master was also specially well acquainted " with this part of the channel, and, getting surrounded with fog, was " heading direct in to the Arran shore; immediately on hearing the " horn away to the eastward he put his vessel about, and, as he described " it to me, could have run his vessel into the landing port at the light-" house. Many similar instances could be given, but the foregoing " may suffice. Further, I have frequently asked both captains and " seamen, and, without exception, their high opinion of its value is " universal." The same Report states that the signal has been heard, during fog, at from 7 to 9 miles against the wind and from 12 to 14 miles down the wind, with light and moderate breeze; and from 3 to 5 miles against a very strong breeze or moderate gale. It is added, that the persons who heard the signal at these distances were either in a sailing vessel on a quiet day or were otherwise free from noise—" it " might be quite different in a steamer under weigh, where the clatter " of machinery and the hissing of steam would render distant sounds " more difficult to be heard." And in a subsequent Report the keeper observes that the examples which he gave were the extreme limits of range which had been reported to him, and that for general practical purposes the horn will not always be heard so far.

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* Minutes of Proceedings, vol. xxxii.

† Washington, 1868.

The foregoing testimony is valuable as being taken from observations made, not on an occasion selected for experiment, during clear weather and with smooth sea and no wind, but in actual practice under unfavourable conditions of wind and weather; and it derives additional weight from the evident care with which attendant circumstances have been taken into consideration. This trumpet is sounded at an initial pressure of 8 lbs. and a terminal pressure of 4½ lbs.

The cost of the Daboll trumpet and the caloric engine, in duplicate, at St. Catherine's, including expense of erection, was £1,338; and an engine-house and keeper's dwelling, of the substantial character of the buildings there, would cost about £1,500. The engine and apparatus erected at Cumbrae cost £600, and the engine-house £400. The working cost of the St. Catherine's signal in 1869 was at the rate of £6 4*s.* 5*d.*, and that of the Cumbrae signal £5 14*s.* 6*d.*, per 24 hours of work, including every expense but repairs, which were in each case estimated at about £10 per annum.

The machine generally employed for condensing the air is Ericsson's caloric engine, the use of which has been adopted from America together with the trumpet. It possesses several features which recommend it for the purpose. It consumes very little fuel—about 12 lbs. of coke per hour; is free from danger of explosion; and, when in good condition, can be started to work in about half an hour. The importance of the latter feature will be appreciated by those who know how suddenly a fog sometimes comes on, and how necessary it is that the fog-signal should commence sounding without delay. It has however been found by experience in America, that the caloric engine is not satisfactory. A Report made in 1869 to the Minister of Marine and Fisheries at Ottawa, by the agent of the department at Halifax, stated:—" One " very great objection to these instruments [Daboll's trumpets] is the " use of the caloric engine instead of steam. They appear to work " very well for a time, but once the machinery from any cause gets out " of repair, no reliance can be placed on its efficient working for any " length of time." The apparatus of the trumpets at Sambro and Cranberry Island, N.S., established in 1865, required almost continual repairs after about two years' working. The Engineer of the Department of Marine and Fisheries states:*—" The expenses for repairs, and " the frequent stoppages to make these repairs during the four years " they continued in use, made them expensive and unreliable. The " expense is perhaps the smallest objection. The frequent stoppages " during foggy weather made them sources of danger instead of aids to " navigation." After giving these signals a very fair trial, it was at length determined to abandon them, and last autumn a gun was established at Sambro, and a steam-whistle at Cranberry Island. Respecting the efficiency of the trumpets themselves, the 1869 Report of the agent, already quoted, states:—"The sound of these trumpets has " become much deteriorated during the last year or so."

The change of the signals at Sambro and Cranberry is not a solitary case. At several stations on the coast of the United States the steam-whistle has been substituted for the trumpet. The risk of stoppage of the signal by the breaking-down of the caloric engine is provided against at Dungeness and St. Catherine's by a duplicate engine being kept in readiness.

A Daboll trumpet was established in July 1871, at the Howth Bailey lighthouse on the east coast of Ireland. I have not heard any particulars as to its efficiency. It is worked by a caloric engine, respecting which Captain Hawes, R.N., Inspector of Irish Lights, states:—" The Bailey being lit with gas, I have found it exceedingly " convenient to use it instead of coal for driving this engine, and " would have continued to do so, had the gas-holder there been of " sufficient capacity to admit of it."† This is, so far as I am aware, the first example of the application of gas to the heating of the caloric engine; and it is probable that with such fuel the fire-box (the weak part of the engine) would not be so soon burnt-out as where coal or wood is used, and that the engine would consequently be less liable to get out of order.

The trumpet of Professor Holmes, sounded by condensed air, is intended to distribute its sound uniformly over an arc of 90° instead of being strongest only in the line of its axis, so that four of them shall form a holophone of 360°; and two light-vessels constructed for China from the designs of Mr. J. N. Douglass, M. Inst. C.E., are thus fitted. The light-vessel at Seven Stones was fitted last November with a Holmes trumpet, worked by a caloric engine.

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* Report to Deputy of Minister of M. and F., Ottawa, 10th January, 1872.

† Report to Commissioners of Irish Lights, 10th April, 1872.

The lighthouse station at Souter Point is provided with Holmes's signal. The trumpets, two in number, are constructed to sound over an arc of 180°, corresponding with the illuminated arc of the light. The air is condensed by the steam engine employed for the magneto-electric light. The condenser and trumpets are distant about 350 feet from the air-pump, and the sounding of the trumpets at regular intervals is automatically effected by a tumbler, which falls over and opens the valve to the trumpets when the pressure rises to 30 lbs. When the pressure is reduced by the blast to 28 lbs., the tumbler falls back and closes the valve until the pressure again rises to 30 lbs. The interval between the blasts, or in other words the time requisite to recover the 2 lbs. of pressure expended, depends upon the capacity of the condenser, which is regulated by the introduction of water.

On applying to the Committee of Lloyd's, they most obligingly wrote to their agent at North Shields to inquire respecting the performance of this instrument, and I am informed that "he has ascertained, on "good authority, that the fog-trumpet . . . . is of great use."* This is satisfactory, as showing the general estimation in which the signal is held by nautical men. It would have been more so, if the precise conditions of wind and weather, and the distance at which the signal was heard, could have been added.

There is also another fog-trumpet, by Anderson, which is established as an auxiliary instrument at Beaver-tail, R.I., and at Long Island, but I have as yet received no details respecting it.

Whistles.

The use of the hemispherical or locomotive whistle as a coast fog-signal appears to have been first suggested by the late Mr. A. Gordon, M. Inst. C.E.,† who proposed to employ air or steam for sounding it, and to place it in the focus of a reflector or group of reflectors in order to concentrate its sound into a powerful phonic beam. The sharpness and shrillness of the whistle were in his opinion its chief recommendations. "When you get a shrill sound high in the scale," he says, "that "sound is carried much further than a lower note in the scale."

The honour of being the first to apply this instrument in practice belongs to the late Mr. C. L. Daboll, who in 1851 erected one at Beaver-tail Point for the United States Government. It was sounded by condensed air, the machinery being the same as that used for the trumpet, in combination or alternation with which it appears to have been employed, and, like that instrument, its performance was efficient

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[*] Secretary of Lloyd's to the Author, 28th March, 1872.

[†] Evidence before Select Committee on Lighthouses, 1845.

and successful. It was distinctly heard, during dense fogs, at a distance of from 6 to 8 miles, in the town of Newport, when there was considerable noise of carriages in the streets. Captain Walden reported very favourably upon it; and the President of the United States Lighthouse Board has placed upon record, from personal observation, his opinion of its great practical value.* The apparatus, having been tested and approved, was at once adopted by the United States Government, and immediate arrangements were made for the erection of four at various points on the coast.

In 1854, Mr. Robert Foulis, of St. John's, New Brunswick, proposed† the employment of the steam-whistle as a fog-signal; and in 1860 was erected the now famous steam-whistle at Partridge Island, St. John's harbour, which may be regarded as the archetype of all subsequent ones. It was erected under the superintendence of Mr. T. T. Vernon Smith, and this type of apparatus is frequently designated by the name of the "Vernon Smith whistle." It is extremely simple in its details. The boiler is tubular, having a superheater, connected with which is the whistle, and the sounding of the instrument is automatically regulated. The apparatus was patented in Great Britain in 1861 by Mr. Barker, for Mr. Vernon Smith.

Respecting the efficiency of this instrument, it is stated:‡—"With a "pressure of from 90 to 95 lbs. the whistle can easily be heard in calm "weather a distance of 6 or 7 miles, and has been heard by a steamer "in a heavy gale, and sea running high, at a distance of 5½ miles to "windward, but it was then not audible till the paddles were stopped." Captain Malcolm, R.N., officially reported in 1863 that, from experiments made by him, in which the sound of the whistle was audible up to 3 miles' distance, against a moderate breeze (4) and during dense fog, he infers that in such weather the sound may fairly be supposed to have a radius of from 3 to 6 miles.§

The use of steam has now, I believe, entirely superseded condensed air for sounding coast fog-whistles in America, and these instruments are extensively employed, both in the United States and in the Dominion of Canada.

In May 1869, the Commanding Officer of H.M.S. "Minstrel" officially examined one at Cape Forchu, Nova Scotia, and made a Report to the Admiral on the station, of which the following is an extract:—"After "communicating with the keeper of the fog-whistle . . . . I "weighed and proceeded head to wind, stopping at intervals to listen to "the whistle, the sound of which was distinctly heard 7 miles and "finally ceased 8 miles off. The wind at the time was S.S.W., force "4, weather foggy. The distance was calculated at first by cross "bearings, and, after the fog set in, by the patent log." The Report goes on to state that, whilst the observations were being pursued on the following day, the engine of the whistle broke down in consequence of a gland on the feed-pump giving way. The keeper not being pro-

* Report of the United States Lighthouse Board, 1852.

† In "The Morning News," 22nd October, 1854.

‡ Report by Commissioner of Public Institutions, N.B., 1864.

§ Report to the Admiral on the Station, August, 1863.

vided with the means of repairing damages, the experiments had to be discontinued. Such a contingency is now provided against by the supply of duplicates of certain parts of the machinery, but the Engineer of the Department of Marine and Fisheries states* that "so far "in practice they have not been put in use."

The subjoined particulars, although of considerable length, are too important and interesting to be omitted:—

"The following statement of results obtained from Steam Fog "Alarms in use in the Dominion of Canada, and the ranges given, are "from actual observation, and are substantiated by the testimony of "numbers of masters of steam and sailing vessels, and others engaged "in navigating the waters of the Dominion and the United States.

"The Steam Fog Alarm on Partridge Island, at the entrance to the "harbour of St. John, N.B., is heard, under favourable conditions of "the atmosphere and light winds, 5 miles to windward and 9 miles to "leeward; and under unfavourable circumstances and strong winds, "3 miles to windward and 7 miles to leeward. Steamers and sailing "vessels making the port of St. John during snow storms, thick, and "foggy weather, run for the harbour with confidence, relying on the "sound of the whistle of the Alarm for distance and position. The "whistle of this Alarm is 5 inches diameter, steam pressure 80 lbs. "Blast 10 seconds duration, once in each minute.

"The Steam Fog Alarm at Cape Forchu, entrance of Yarmouth "harbour, N.S., has frequently been heard (overland) at Barrington, "a distance of 30 miles from the Alarm, and at Seal Island, N.S., "26 miles from the Alarm, at times when the state of the atmosphere "was favourable for the conveyance of sound, wind light. This "Alarm is heard by persons on steamers and other vessels 8 miles to "windward in a strong breeze; in light winds 10 and 12 miles to "windward. The whistle of this Alarm is 8 inches diameter, steam "pressure 75 lbs. Blast 10 seconds duration in each minute.

"The Steam Fog Alarm on Seal Island, off the S.W. point of Nova "Scotia, is heard on the mainland 18 miles distant. The masters of "steamers plying between Boston and Portland, U.S., and Halifax "N.S., report that they run for the Alarm on Seal Island, and "generally hear the Alarm from 40 to 50 minutes before they make "the island. Fishing vessels frequent the waters around Seal Island, "and the fishermen report that the Alarm is invaluable, as they can "by the sound of the Alarm (knowing its position) shape their course "to clear the reefs lying off the island, or make a harbour on the "mainland, in dense fogs and thick weather. Before the Alarm was "put on this island, the fishermen were obliged, in stormy weather with "fog, to run to sea. The whistle of this Alarm is 8 inches diameter, "steam pressure 75 lbs. Two blasts (of 5 seconds duration each, with "an interval of 5 seconds between the blasts) in each minute.

"The Steam Fog Alarm at Point Lepreau in the Bay of Fundy has "been heard in foggy weather and snow-storms 25 miles along the "coast, 15 miles inland, and 20 miles at sea, under favourable condi-

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* Report, *ubi sup.*, 10th January, 1872.

" tions. The International Company's steamers, owned in the United " States, pass Point Lepreau, the site of this Alarm, 8 times a week in " the season when fogs are prevalent. The officers of these steamers " report that they hear the Alarm from 35 to 40 minutes before the " steamer arrives abreast of the Point. The speed of these steamers is " fully 12 miles an hour (they say 13), consequently they hear the " Alarm 7 or 8 miles distant, the steamer being at full speed, and " making the noise usual to paddle steamers running at full speed. " The whistle of this Alarm is 8 inches diameter, steam pressure 75 lbs. " Two blasts (of 5 seconds duration each, with an interval of 5 seconds " between the blasts) in each minute.

" The Steam Fog Alarm at the entrance of Digby Gut, N.S., put in " operation 1st January 1872, was heard from the deck of the steamer " 'Empress' 45 minutes before she passed the site of the Alarm in " entering the Gut. Captain Leary judged the Alarm 6 miles distant " when first heard; the time and speed of the steamer made the " distance nearly 7 miles; the wind was very strong at the time, " blowing in a direct line from the steamer towards the Alarm, the " steamer running before a heavy sea, pitching and rolling, the " atmosphere very cold and dry, wind N.N.W., all unfavourable con-" ditions for hearing the sound of the whistle of the Alarm. This " Alarm was being tried on this occasion for the first time, with a " pressure of 65 lbs. per square inch. Later the same day, the Alarm " was distinctly heard by the captain, crew, and passengers of the " steamer, at Annapolis, N.S., 20 miles distant from its site and at a " right angle to the direction of the wind. The whistle of this Alarm " is 8 inches diameter, steam pressure 75 lbs. Blast 8 seconds dura-" tion in each minute. The boilers of the Alarms already mentioned " use fresh water.

" The Steam Fog Alarm on the iron light-ship at Red Island Shoal, " River St. Lawrence, has been heard 3 miles to windward and 15 miles " to leeward. The whistle of this Alarm is 10 inches diameter, steam, " pressure 60 lbs., and gives a blast of 10 seconds duration in each " minute. The boiler of this Alarm is constructed to use salt water."

Then follows a description of the whistle at Anticosti, diameter 8 inches, steam pressure 80 lbs.; and at Cranberry Island, 10 inches diameter, steam pressure 60 lbs., but it is added that no definite information had been obtained as to the distances at which they can be heard. The Report then proceeds:—

" The average consumption of fuel is 1,000 lbs. of Anthracite coal or " 1,120 lbs. of Welsh coal, in 24 hours. The Welsh coal furnished to " some of the Alarms last season cost $5·00 [20*s.* 10*d.* stg.] per ton " of 2,240 lbs., making cost of fuel for 24 hours $2·50, [10*s.* 5*d.* stg.] " exclusive of carriage and other charges.

" The cost of a Steam Fog Alarm with an 8-inch whistle, completed, " ready for operation, is $1900·00 [£395 16*s.* 8*d.* stg.]. When the boiler " is intended to use fresh water, the weight is 3 tons. This sum " includes the steam-pump, which is used as a fire-engine if required. " The building for the Alarm, conveying to place of erection, pro-" curing water, and outfit required, are not included, as these expenses " are governed by circumstances of distances, site, &c.

“The cost of an Alarm with a 10-inch whistle, with the boiler to use salt water, is $3000·00 [£625 stg.]. . . . . .

“The duration and frequency of the signals as arranged, have in practice been found sufficient. The United States coasting steamers are generally very swift, and enquiry by the American Government was made of the masters of these steamers in this matter, and the replies stated that they considered the signals as arranged by the Dominion Government quite reliable and sufficient.”*

During the years 1862–3–4–5, the Partridge Island whistle was in operation on an average 888 hours 47 minutes in each year, at an average cost, including wages, stores, repairs, and every expense, of £3 13*s*. 0*d*. per 24 hours of work.† I have no details of the working cost of the other whistles; but, with perhaps the exception of that at Anticosti, it probably does not materially differ from the above.

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* Engineer's Report to Deputy of Minister of M. and F., Ottawa, 10th January 1872.

The following details of cost of the fog-signal stations mentioned in the above Report, are of considerable practical interest. The cost of the apparatus is higher than stated in the Report, probably covering the expense of outfit, stores, &c. I have reduced the prices in this table, as well as those in the Report, to sterling at 4*s*. 2*d*. per $.

	£	*s*.	*d*.	£	*s*.	*d*.
Yarmouth Steam Fog-whistle :—						
Apparatus	432	5	10			
Buildings	256	5	0			
Plans, Specifications, and Incidentals	30	8	4			
				718	19	2
Seal Island Steam Fog-whistle :—						
Apparatus	522	5	10			
Buildings	361	9	2			
Reservoir	275	8	4			
Plans, Specifications, &c.	17	10	0			
				1176	13	4
Point Lepreau Steam Fog-whistle :—						
Apparatus	458	2	6			
Buildings	258	19	2			
Digging Wells	36	5	0			
Plans, Specifications, &c...	36	5	0			
				789	11	8
Digby Steam Fog-whistle :—						
Apparatus	578	6	8			
Buildings	364	11	8			
Plans, tracings, &c.	18	6	8			
				961	5	0
Cranberry Steam Fog-whistle :—						
Apparatus and Buildings..				2114	11	8
Anticosti Steam Fog-whistle :—						
Apparatus	791	13	4			
Buildings	729	3	4			
Plans, Specifications, &c...	40	4	2			
				1561	0	10
Red Island Light-vessel Steam Fog-whistle :—						
Apparatus	817	5	10			
Plans, Specifications, &c...	15	17	7			
				833	3	5

† Secretary of Commissioners of Public Institutions, N.B., to Controller, 18th August 1866.

In 1869 a steam-whistle apparatus, on the American principle, was established at Girdleness by the Aberdeen Harbour Commissioners, under the superintendence of their Engineer, Mr. W. D. Cay, M. Inst. C.E. He informs me that the whistle is 6 inches diameter, sounded at a pressure of 60 lbs., and that the signal is said to be very useful to captains of steam-vessels seeking the harbour in foggy weather. I have not, however, heard of any experiments being made as to its effective range.* Its total working cost in 1870 was at the rate of £4 5*s.* 1*d.* per 24 hours of work.

Several trials of steam-whistles have been from time to time made by the Commissioners of Irish Lights; but considerable hesitation as to the propriety of adopting such a fog-signal appears to be caused by the fear of confusion arising from the use of similar instruments by steamers and locomotives.† Such confusion, if found to occur in practice, would undoubtedly be a serious objection; but the extensive adoption of this signal on the American coast, and the absence of any evidence of accidents having occurred from that cause, render it almost certain that the difficulty is more formidable in appearance than in reality. Mr. T. Stevenson, M. Inst. C.E., one of the Engineers to the Commissioners of Northern Lighthouses, in noticing‡ a similar objection, points out that it may be obviated by employing a whistle producing a peculiar and distinctive sound, and by adopting a certain general uniformity in the blasts and silent intervals of the signal.

In 1865 a plan was proposed by Mr. H. T. Humphreys, M. Inst. C.E. (to which he gave the name of "Clamor Æstus"), for sounding a whistle by a strong percussive blast of air, obtained by the fall of a heavy weight upon a piston working air-tight in a cylinder communicating with the whistle. It is stated, that the sudden compression of the air by this means, and the violence with which it would be driven through the whistle, would produce a sound of great shrillness and intensity, entirely peculiar and characteristic. In this opinion I am quite disposed to agree. Mr. Humphreys experimented successfully on the action of the percussive blast;§ but the expense of the construction of a complete apparatus on his principle prevented its trial in actual practice in all its details. This is to be regretted, and not the less so because the plan proposed included an ingenious application of tidal power to the working of the machine.

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* The term "effective range" is used throughout this Paper (except where words not my own are quoted) in one sense only, signifying *the actual distance at which, under the most unfavourable circumstances of wind and weather, a signal can always be heard on board a paddle steamer under way in a heavy sea.* Whether the distance be long or short (which depends upon the power of the instrument), that is the "effective range" of the signal, or the signal is said to be "effective" at that range or distance.

I am indebted to Admiral Ryder for pointing-out, that a limit to the strength of the wind against which a fog-signal is to be considered "effective," should be placed at that force beyond which a vessel could not carry sail enough to be manageable—since, if the wind exceeded that strength, the signal could be of no service even if heard.

† Capt. Hawes, Report to Commissioners of Irish Lights, 10th April, 1872.

‡ Trans. Royal Scottish Soc. of Arts, vol. vii., p. 204.

§ Mr. H. T. Humphreys to the Author, 24th January. 1871.

Various methods have been suggested for concentrating and directing the sound of the whistle. The proposal of the late Mr. A. Gordon was, to place the whistle in the focus of the double reflector of Bordier Marcet's apparatus, for the purpose of directing the sound into a horizontal plane, answering to a fixed light; or in a focus common to a group of three parabolic reflectors revolving on a vertical axis, answering to a revolving light of the same number of faces. In 1860 Mr. E. A. Cowper, M. Inst. C.E., laid before the Trinity House of London a proposal to employ a gigantic parabolic reflector or trumpet, having an axial length of from 25 to 40 feet according to the requirements of the case. The trumpet was to be made to revolve over any required arc, corresponding to a revolving light of one face. In 1864 Mr. T. Stevenson devised a peculiar combination of reflecting surfaces, constructed of $\frac{1}{16}$-inch sheet iron, and arranged on the principle of the reflecting prisms of an apparatus for light, viz., that of arresting and sending forth in suitably parallelized rays all the sound emitted by the whistle. This instrument, of which a detailed description is contained in his work on "Lighthouse Illumination,"* and to which he gives the characteristic name of "holophone," was experimentally tried in 1865 by direction of the Commissioners of Northern Lighthouses, with the approbation of the Board of Trade. "The result of these experiments, "which were made with a *low* power of steam, was, that while at "moderate distances of about 1½ mile, the holophone was very much "louder than a naked whistle supplied from the same boiler, the "difference between the maximum distances at which each could be "heard was less than might have been expected from the results "obtained at lesser distances. Thus, while at the distance of about "2 miles the holophone was very much louder, the naked whistle died "out at 3 miles, and the holophone between 3 and 4 miles."†

The practical value of any scheme relating to the collection and distribution of the sound of a whistle or other radiant can only be determined by tentative and careful experiment; and the principal obstacle to be overcome will probably be found to be the difficulty of getting rid of the volume of steam escaping in the act of sounding, which, if suffered to fill the reflecting apparatus, must tend more or less to deaden and stifle the sound.

One of the essential requisites of a fog-signal is, that it shall indicate with tolerable exactness the direction from whence the sound proceeds. Some interesting experiments made by Mr. J. H. Alexander in 1855, showed that with a steam-whistle this could be readily determined within an arc estimated to be of 3° or 4°, at a distance of 3½ miles. The whistle employed had a screw-thread on the stem supporting the upper or inverted bell, which regulated the distance of the sounding-lip from the annular steam-orifice. Mr. Alexander pointed out how necessary it is that the feather-edged sounding-lip should everywhere coincide with the central line of the opening. The importance of this coincidence is strikingly illustrated by a case stated to me by Professor Holmes, of a whistle of French manufacture upon which he made some experiments, and in which he found that the non-efficient portions amounted to fourteen-fifteenths of the whole circumference. I mentioned this circumstance to Mr. John Bailey, of Salford, whose "steam-roarer" was so favourably noticed in Captain Brent's Paper; and he obligingly tried some experiments with the view of ascertaining whether any portion of his own whistles could be blanked without diminishing the sound—the result of which would have been to confirm the conclusion pointed-to by Professor Holmes's experiment, that all steam-whistles are in this respect defective, and that increased accuracy in the coincidence of the steam-slot and the sounding-lip is required in order to develop the full power of the whistle. Mr. Bailey, however, who intercepted the steam at various points in the circumference, found that the sound of the whistle diminished just in proportion to the length of slot stopped; and the inference is, that the whistle experimented upon by Professor Holmes was unusually defective, or, at any rate, very inferior in accuracy of fitting to the best specimens of English manufacture.

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* 2nd edition, p. 194–196.

† "Lighthouse Illumination," 2nd edition, p. 197.

Mr. Alexander's experiments tended to show that the most effective working pressures are from 40 lbs. upwards. His investigations extended over a variety of other practical details connected with the steam-whistle, for the particulars of which I must refer you to his very able and interesting Report.*

Syrens.

The syren is an instrument in which the sound is produced by the alternate passage and stoppage of air or steam by means of a revolving disc or cylinder pierced with holes. The pitch of the note thus produced depends upon the rapidity with which the alternations are made. Several instruments upon this principle, sounded by steam, are now in actual use as fog-signals in the United States.

Last year Mr. Adolphus Brown, of New York, brought out a fog-trumpet on the principle of the syren. This instrument has been highly commended by Professor Henry, as a fog-signal of great power, and has been by him recommended for adoption at four lighthouse stations in the United States.

Of the mechanical construction of the above-mentioned instruments as used in actual practice, and their ascertained range, I am not as yet in possession of sufficient details to enable me to lay before you any definite statements. It may not, however, be out of place to remark, that the sound of the syren is a true musical note of great purity; and that it is a question which has not yet, so far as I am aware, been satisfactorily answered, whether pure notes or discords have the greatest effective range in fog and against wind.

Such, then, are the instruments at present known to us as fog-signals. I say, at present, because other means have been proposed for making those signals, and there is no ground for assuming that we have as yet by any means exhausted invention upon the subject. Nearly half a century ago, M. Colladon demonstrated the possibility of transmitting sound through water to very considerable distances; and he ultimately succeeded in so transmitting distinctly audible signals to a distance of upwards of 21 miles. The subject has, down to a recent date, engaged the attention of many eminent scientific men, whose careful researches and hopeful anticipations respecting it sufficiently show that the idea is far from being of such a speculative and unpractical nature as might be supposed. Captain Brent is now engaged in pursuing inquiry and experiment in this direction, and deserves, as he doubtless has, our best wishes for his success.

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* "Report on Fog-signals by Steam, addressed to the Committee on Experiments of the U.S. Lighthouse Board," Washington, 1861.

Reverting, however, to the recognized and established methods of fog-signalling, it will now be proper to inquire to what extent they are severally suited to the requirements of navigation. And this raises the preliminary questions:—What is a fog? In what manner does it affect sound? and, What are the requirements of navigation in connexion therewith?

Fog has been defined as being "the moisture evaporating from the "warm earth, or river, or sea, condensed at once by the colder air," and as "a cloud resting on the earth."* But there is this difference between fog and cloud; that whereas a person may be enveloped for a length of time in some fogs without being sensible of damp, it is altogether otherwise with cloud, a circumstance which will be within the recollection of all who have had much to do with mountaineering. M. Ch. Martins, it is true, asserts that fogs are always more or less perceptibly damp;† but he also quotes the experience of De Saussure and Humboldt on the opposite side of the question. However, whether fogs are characterised by dryness or humidity, it is agreed that they consist either of aqueous globules or of aqueous vesicles, of extreme minuteness, held in suspension in the air. It is possible that the appreciable dryness or moisture of a fog may depend upon the electrical tension of the air thus charged.

Now experience has shown that fog has the effect upon sound, of either deadening and muffling it, or entirely stifling it, at very variable distances; its apparently irregular action in this respect being doubtless regulated by certain laws of order, and depending probably upon the number, density, and elasticity of the particles composing it. It has also been observed‡ that falling rain, and especially falling snow, has a similar and powerful effect upon the transmission of sound. These phenomena have been referred to the general law, that a non-homogeneous body will not vibrate in unison as a whole, or, in other words, will not freely propagate sound; but the precise manner in which that law operates with respect to fog, snow, and similar atmospheric obstructions has not, so far as I am aware, been hitherto explained. The solution which I venture to offer was suggested by the following case proposed by the Rev. S. Earnshaw, in treating of the propagation of sound through a tube. He says:—"Suppose a portion of the tube to be filled " with air of a different kind from that which fills the first part " . . . . and to prevent the two airs or gases from mixing, let " them be supposed to be separated by an impenetrable film without " weight and inertia. . . . . Let now a wave be generated in the " first medium and transmitted towards the second; then when it has " reached the common boundary of the media, the velocities of the " particles in contact with the film on both sides will always be equal. " Let U′ be this velocity at any moment, and U the velocity which the " film would have had at that moment, if the second medium had been " the same as the first. Then U—U′ is the velocity lost by the par- " ticles of the first medium by the resistance due to their contact with " the film. In other words, this velocity has been impressed on the " particles of the first medium by the resistance of the film, in the " reflex direction. This gives rise to a reflex wave in the first medium, " which we may consider superimposed on the wind of the original " wave."* The "second medium" here mentioned may be supposed to represent the aqueous particles of fog or mist, or the flakes of falling snow, each of which converts a portion of the direct sound-wave into a reflex wave; and as these particles are exceedingly numerous, they reflect a certain amount of every portion of the wave. The wave, thus weakened, but still travelling onward, is again broken and partially reflected by the particles which it encounters. Those portions of the original wave which strike against the particles of the obstructing medium otherwise than normally to their surface, are reflected not in a direct but in an oblique line, and are again reflected obliquely by other particles. These direct and oblique reflections are repeated again and again, until, if the obstructing medium be of sufficient extent, the whole of the original sound-wave is ultimately broken-up into a confused ripple, possessing less and less of a distinctive character, and less and less power to affect the sense of hearing, according to the extent to which its constitution as a sound-wave has been destroyed.

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* Dr. Gladstone, "On Fogs and Fog-signals," Proceedings Royal Institution, vol. iv., p. 55.

† "Il est incontestable que le degré d'humidité des brouillards est variable; mais il n'est point encore démontré qu'il existe des brouillards assez denses pour voiler des objets situés à un kilomètre par exemple, et secs au point de n'affecter en rien des instruments psychométriques [hygrométriques?] delicats: à moins que ces brouillards ne soient de la fumée produite par de grands combustions." Martins, Essai sur les Brouillards Secs, p. 228.

‡ Dr. Derham, "De Soni Motu." Phil. Trans., vol. xxvi., p. 24–25.

This view of the case is corroborated by some statements of Professor Tyndall. He says:—"Sounds are also reflected from the clouds. " When the sky is clear, the report of a cannon on an open plain is " short and sharp, while a cloud is sufficient to produce an echo like " the rolling of distant thunder. A feeble echo also occurs when sound " passes from one mass of air to another of different density." He then quotes Humboldt's account of the distant sound of the falls of the Orinoco being much louder by night than by day, and gives the following as Humboldt's explanation of the phenomenon:—"Between him " and the falls lay a vast grassy plain, with . . . . . rocks protrud- " ing from it. When exposed to the sun, these rocks assumed a tem- " perature far higher than that of the adjacent grass; over each of " them therefore rose a column of heated air, less dense than that which " surrounded it. Thus by day the sound had to pass through an " atmosphere which frequently changed its density; the partial echoes

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* "On the Mathematical Theory of Sound." Phil. Trans., vol. 150.

" at the limiting surfaces of rare and dense air were incessant, and the " sound was consequently enfeebled. At night those differences of " temperature ceased to exist, and the sound-waves, travelling through " a homogeneous atmosphere, reached the ear undiminished by reflec- " tion."* Such being the effect of the surfaces of contact of masses of the same medium, where the difference of their densities is but slight, it will be at once apparent that the interposition of particles or films of a substance totally different in density and elasticity would produce the same effect in a much greater degree.

If the above be, as I believe it is, a correct explanation of the manner in which fog acts upon sound, it appears singular that the relative penetrating effect of different sounds depends quite as much upon their character as upon their relative volume or initial power. Hence it is conceivable that sounds which consist of a great number of different waves, may contain some of the undulations which are of a character not easily reflected by the particles of the obstructing medium, and which will therefore pass through that medium with little change, whilst the remainder are arrested and lost; in a manner remotely analogous to the phenomenon of the apparent change in the colour o the sun when viewed through fog, or through the aqueous vapours near the horizon at sunset.† In both cases, the change is due to the stoppage or absorption of certain rays by the interposed medium. I do not see how, except upon some such hypothesis, we can account for the penetrating power of certain sounds—notably those of the whistle and the reed-trumpet, consisting of an indefinite number of slightly different vibrations, all however forming one general wave, as the tidal wave bears upon its bosom an endless variety of minor undulations—whilst the sound of bells, the report of cannon, and even the awful crash of thunder, the sound-waves of which are of a comparatively simplex and uniform character, though the two latter are of enormous initial power, are frequently lost at short distances.‡

Obscuring media occasionally held in suspension in the atmosphere are not the sole obstacles to the free propagation of sound. It is also powerfully affected by the action of wind blowing from the observer towards the source of sound. This is usually attributed to the circumstance of the whole mass of air through which the sound is travelling being carried bodily away from the observer, so that by the time the sound reaches him it has had to travel through a greater distance, and thus has practically had its point of origin so much further removed from him. This view of the case, however, overlooks the fact that the velocity of sound is so enormously greater than that of the swiftest wind, that the diminution arising from this cause can be but very slight. Professor Stokes, Sec. R. S., has given an explanation of the phenomenon, in a manner at once so simple and so satisfactory, that it leaves nothing to be desired; and, as the subject is of much importance in its relation to fog-signals, I give it in his own words:—

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* Tyndall's Lectures on Sound, 2nd ed., 1869, p. 18–19.

† The sun under these circumstances appears of a red colour; and it may be observed, as a somewhat singular coincidence, that a blind man is said to have described the colour of red or scarlet as being suggested to him by the sound of a trumpet—one of the instruments whose sound is the most efficient in penetrating fog.

‡ In the case of guns, this has been stated to be owing to the instantaneous character of the sound produced by the explosion of gunpowder (R. Stevenson, "Bell Rock Lighthouse," p. 231); but this, although it will account for the simplicity of the sound-wave emitted, does not appear sufficient of itself fully to explain the cause of the speedy extinction of that sound by fog.

"If we imagine the whole mass of air in the neighbourhood of the "source of disturbance divided into horizontal strata, these strata do "not all move with the same velocity. The lower strata are retarded "by friction against the earth, and by the various obstacles they meet "with; the upper by friction against the lower, and so on. Hence the "velocity increases from the ground upwards, conformably with obser-"vation. This difference of velocity disturbs the spherical form of the "sound-wave, tending to make it somewhat of the form of an ellipsoid, "the section of which by a vertical diametral plane parallel to the "direction of the wind is an ellipse meeting the ground at an obtuse "angle on the side towards which the wind is blowing, and an acute "angle on the opposite side. Now, sound tends to propagate itself in "a direction perpendicular to the sound-wave; and if a portion of the "wave is intercepted by an obstacle of large size, the space behind is "left in a sort of sound-shadow, and the only sound there heard is "what diverges from the general wave after passing the obstacle. "Hence, near the earth, in a direction contrary to the wind, the sound "continually tends to be propagated upwards, and consequently there "is a continual tendency for an observer in that direction to be left in "a sort of sound-shadow. Hence, at a sufficient distance, the sound "ought to be very much enfeebled; but near the source of disturbance "this cause has not yet had time to operate, and therefore the wind pro-"duces no sensible effect, except what arises from the augmentation in "the radius of the sound-wave, and this is too small to be perceptible."*

I have dwelt somewhat at length upon this matter, not only because the theory of Professor Stokes at once commends itself as a satisfactory solution of an otherwise perplexing question, but also because that theory enables me to propose a practical expedient for increasing the effective range of sounds required to be sent against the wind. It is as follows:—Since those sounds have a tendency to rise, and, if originally directed in a horizontal plane, are diverted upwards in a curve convex to the horizon, they ought to be in the first instance projected in a downward direction, at an angle proportioned to both the strength of the wind and the distance at which they are required to be best heard, so as to counteract the rising tendency. Sounds to be sent across the wind should be projected slightly downwards, and those to be sent down the wind should be projected in a horizontal plane. In making this suggestion, it affords me much gratification to add that Professor Stokes, to whom I have submitted it, informs me that he considers the practical inference thus drawn from his theory to be well founded.†

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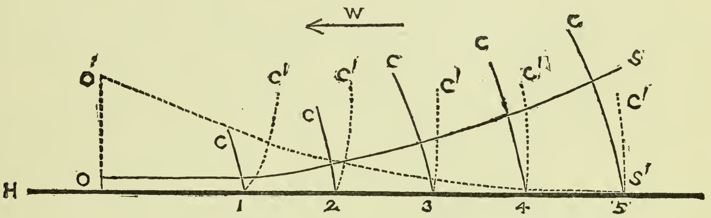
* "On the Effect of Wind on the Intensity of Sound." Report of the British Association, vol. xxvi.

† In the accompanying diagram, the full lines illustrate the case of a sound emitted near the sea-level, and the dotted lines that of one emitted at an e

From this view of the case it will be perceived that there is no necessity for seeking to place a fog-signal low down, but that on the contrary it ought to be situated at a height such as will allow its sound to be projected at the required depression and at the same time clear of any rocks or other obstructions on or near the shore; and in this clearance of impediments near at hand an elevated situation possesses another decided advantage over a low one.* Owing to the diffraction of sound, the signal will be audible at points within the distance to which the principal phonic beam is directed.

In order to guard against misapprehension arising from the idea that sound projected downwards from a height has to penetrate a greater thickness of fog† than when projected horizontally from near

and suitably depressed. Let H S′ represent the surface of the sea; O the point of origin of the sound at the low station; O′ that at the high station; 1 C, 2 C, 3 C, &c., a vertical section, parallel with the direction of the wind, of the curves of the sound-wave from the low station, at the horizontal distances 1, 2, 3, &c.; 1 C′, 2 C′, 3 C′, &c., those from the high station (the curves in each case being exaggerated, to render them more distinct); W the direction of the wind; and S′ the point at which the signal is required to be best heard. A sound emitted from O, travelling in a line normal to the curves of its wave, will gradually rise until, at the distance 5, it will be at the point S. As no phonic ray can be sent direct to S′ from O, the space between the lines O S and H S′ will be in sound-shadow, the only sound which reaches S′ being what diverges from the general wave below the line O S, and, owing to the rising of this line, the distance between it and the sea-level becomes greater and therefore the divergent sound heard at that level becomes weaker, as the distance from O increases. A sound emitted from O′, at a suitable depression, travelling in a line normal to the curves of its own wave, gradually approaches the surface of the sea, which it reaches at the point S′, as intended. In this case also (if no phonic ray be emitted at a greater depression), the space between the lines O′ S and H S′ is left in sound-shadow, but with this important difference, that, owing to the depression of the line O′ S′, the divergent sound heard at the sea-level increases in strength as the distance from O′ increases.



* Whilst engaged lately in making a small survey on the Welsh coast, I had occasion to try in practice the principle above stated. The weather at the time was boisterous, and it was blowing very fresh. Several times when my men were to windward of me, although at no great distance, it would have been impossible to communicate vocally had I shouted point-blank at them; but by directing my voice towards the ground between us, I was able to make them hear.

† In order to simplify expression, I shall in the remaining portion of this Paper (except in quotations) employ the general term "fog" to denote any atmospheric obstruction, whether it be cloud or mist, falling snow, sleet, thick rain, or true fog; and the term "true fog" will be used when it is intended to restrict the meaning to fog in a purely meteorological sense.

the surface of the sea, it will be sufficient to point out that, if the difference of level between two stations be 150 feet, and the horizontal distance to which the sounds from each are directed be 2 miles, the difference of hypothenuse and base, or in other words the additional distance to be traversed by the sound from the upper station, amounts to only 11 inches, and, the greater the distance to which the sound is directed, the less does this difference become.

I refrain from at present entering upon the details of the application of this principle, because the considerations involved therein are of a somewhat complex nature, the full investigation of which would constitute a Paper in itself, and must be reserved for separate treatment. But it may here be added that, provided as we are with instruments suitable to the purpose, the principle is of easy application in practice.

The requirements of navigation in connection with fog-signals are as follows:—First, the signal must be distinctly audible, under the most unfavourable circumstances, at such a distance as will enable the mariner to profit by the warning it conveys. Secondly, the direction from whence it comes must be readily ascertainable. Thirdly, it should be of such a distinctive character as to indicate, not only that there is a signal station there, but also what particular station it is.

As to the first of these requirements, the most unfavourable conditions of weather are, thick fog, with a whole gale of wind on-shore, and a heavy sea running. Respecting the space required by a ship, under these circumstances, in wearing round to haul off shore, Captain Brent informs me that a large Australian clipper—which, owing to her length and sharpness of build, I presume to be the type of sailing-vessel most exacting in that respect—will require from three-quarters of a mile to a mile, allowance being made for the effect of a heavy sea upon her drift during the process. This estimate is confirmed by the opinion of merchant captains whom he consulted, who had had extensive experience in command of large Indiamen. Even our large ironclads would not require more room than above stated, since, in heavy weather or when nearing the land, they always have steam up, and Captain Brent adds that he has seen no sea towards which they will not turn. It may, therefore, be considered that, allowing a margin for safety, 2 miles is the effective range requisite in a fog-signal. In situations where there are outlying dangers beyond the signal, this range must extend 2 miles clear beyond those dangers, if not too distant—in which case it would be folly to attempt to cover them by a signal stationed on shore—and therefore in some cases the signal may be required to have an effective range of 3 miles. Admiral Sir Alexander Milne, to whom I have also applied in reference to this question, points out, what it is important to bear in mind, that in fog a prudent person would not run down to less than a mile and a half from a suspected danger, and would keep the lead going.

From the details already given respecting various fog-signals, it will be quite evident that the only instruments possessing sufficient range to fulfil the first requirement are trumpets, whistles, and perhaps guns.* The use of a gun, however, is open to the following grave objection. A single gun cannot be continuously worked, loaded, and fired, by one man, at intervals of less than a quarter of an hour, and it has been already pointed-out that even this entails very severe labour. Now a vessel going only 8 knots passes over 2 miles in that time; and therefore, even on the assumption (which is far from being confirmed by facts) that the effective range of a gun is 2 miles, if the vessel comes within range just after the gun has fired she will be close in with the signal before it is repeated. The average chance is that she will come within range midway between the signals, in which case she will run 1 mile before the signal is repeated, and will then be within 1 mile of the station, which, as has been already shown, is too close. To meet the difficulty, two or more guns may be employed, so as to shorten the intervals of firing: but this will necessitate the employment of additional gunners and the expenditure of more stores and ammunition, increasing to an extravagant amount the heavy working cost of the signal, already nearly three times as great as that of the most expensively worked trumpet or whistle.

It may be urged, in reply, that in the great majority of cases of fog the wind is either light, or fair, or off-shore, and that to instance the requirements of a ship in such a combination of unfavourable conditions as has been described is to assume an extreme case. But it is precisely with extreme cases that we are bound to deal in this matter, and I entirely decline to consider any others.

The selection then lies between the trumpet and the whistle, and the evidence respecting the efficiency of both appears to warrant the employment of either. Where a trumpet already established has been carefully tested and found to have the requisite effective range, it may with propriety be retained until the cost of repairs, which we have seen to be a fatal objection in some cases, renders it expedient to renew the apparatus. In such an event, or where a new station is to be established, I should (excepting in a case to be mentioned under the third head) give the preference to the whistle, on account of its superior efficiency and its slightly lower working cost.

With reference to the second requirement of navigation, viz., that the direction in which the signal lies shall be readily determined, some evidence has been already adduced of the efficiency of both the trumpet and the whistle, and although it is not intended to assert that they are absolutely reliable in this respect, it is at least certain that they are superior to any other known signal. As regards the efficiency of guns, the experience already quoted of Admiral Sir Alexander Milne is distinctly in their favour, and deserves attentive consideration. But I am bound to add that this is the only direct evidence upon the subject which has come under my notice; and it may reasonably be doubted whether a momentary explosion occurring only every fifteen minutes can be so readily referred to its true bearing as a signal lasting five or ten seconds and repeated twice or thrice in every minute.

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* And perhaps also syrens; but I do not include them, because we have not as yet sufficient evidence respecting their effective range.

The third requirement of navigation, that the signal shall be of such a distinctive character as at once to indicate its identity,* is one which equals if it does not even exceed in importance the distinctive character of a light. For the comparative clearness of the weather which enables a light to be seen, presupposes that a previous view of the land in the case of a coaster, or the usual observations in the case of a vessel from over-sea, may have enabled the ship's reckoning to be kept with sufficient accuracy to afford some notion as to her whereabouts. But as regards a fog-signal, the very fact of its being in operation suggests that other sources of information as to her position are not available. The distinction of lights into fixed, revolving, and flashing, is necessary to prevent confusion and uncertainty arising from their great number and frequent proximity to each other, and the same remark will apply to fog-signals. Very considerable attention is accordingly paid in America to the preservation of a distinctive character in those signals, both by variations in the intervals and duration of the sound, and by the use of different instruments at different stations.

The trumpet, the whistle, and the syren, are capable of being varied in their character to a degree which renders them in this respect the most efficient of instruments. Their long and short blasts, and long and short intervals, which can be regulated with the greatest nicety and combined in any required manner, afford the means of almost indefinitely varying the signal, and admirably adapt them also for telegraphic—or rather, telephonic—purposes. Viewed in relation to their very distinctive sounds, all three are equally valuable, and the judicious selection of one or the other for any particular station is a matter of no slight importance. It is to be borne in mind, that even if the exact number or duration of their blasts should escape observation, still, if the observer knows that the signal at a certain point is (say) a whistle, and that the signal next to it on one side is a trumpet and on the other a syren, he cannot err in the determination of his position unless he be uncertain respecting it to an extent amounting to the distance between three different stations; which is evidently a better state of things than if he knows that the same description of instrument is used at several consecutive stations, and that his only chance of identifying the signal is to be very exact in noting the duration and arrangement of its blasts and intervals.

The difficulty which appears to be experienced in obtaining a sufficiently diversified code of gun-signals even on board men-of-war, where no lack exists of either men or pieces, shows how incapable of variation must be the ordinary gun fog-signal at a station on shore. One man cannot make the signal at less than quarter-hour intervals; and to make the intervals longer as a distinction would only render the signal more defective, for the reasons already stated under the first head.

In treating of the requirements of navigation, all reference to bells has been omitted, because they occupy a peculiar position. The evidence respecting their effective range is extremely unsatisfactory; and that respecting the facility with which the direction from whence their sound proceeds can be recognized, is confined to the case at Kingstown, already mentioned.* As regards their distinctive character for locality, that may be secured by a judicious arrangement of the intervals of their striking. But the peculiarity of their position consists in this,—that they are as yet the only fog-signals available at rock lighthouses, the present arrangement of those buildings being unsuited to the establishment and working of either a caloric or a steam engine. A whistle, placed on the summit of the lantern, would be safe from injury by the sea; but the manual working of any instrument depending for its sound upon the compression of air would entail an amount of labour requiring the services of relays of men, and is therefore out of the question. There is, however, a mighty agent constantly at work, in the rise and fall of the tide, which has already been sought to be applied to this purpose. It is the agent proposed by Mr. Humphreys for the working of his "Clamor Æstus;" and recently Signor Tommasi has proposed to apply it, in the "Flux Motor," to the driving of pumps for the compression of air. The situation of a rock lighthouse—usually far advanced seaward, and indicating either a danger to be avoided or a leading mark to be sought-for—seems especially to demand an efficient fog-signal. It is therefore of the highest importance that some scheme should be devised for supplying this demand. I have little doubt that the ingenuity of man will one day overcome the difficulties which at present beset the utilization of the vast motive power gratuitously offered by bountiful Nature for our acceptance; and, when this is accomplished, even a rock lighthouse may be found to possess an efficient fog-signal.

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* The importance of this matter is pointed-out in the Report of the Royal Commission on Lighthouses, 1861, p. xi.

It would be in the highest degree satisfactory, were it possible to conclude that in the trumpet and the whistle we possess instruments entirely fulfilling the requirements of navigation. With the exception, however, of the conditions involved under the third head, such is not the case; and, notwithstanding the favourable evidence which has been adduced respecting them, all that we are as yet entitled to say is, that they are superior to any other known instrument. Much additional information remains to be acquired before we shall be in a position to pronounce either of them to be perfectly efficient and reliable.

Now the acquisition of this information may be effected in one of two ways; either by awaiting, with more or less attention and desire of being instructed, the results of investigation and experiment elsewhere; or by investigating and experimenting for ourselves. The former method will be preferred, where a small economy of trouble and expense in the first instance is the object of primary importance. But it is attended with this disadvantage to those who follow it, that they must either remain always behind the times, or else be perpetually exposed to the risk of adopting an instrument which on more extended trial in practice is found not to be a success. And, as regards expense, the cost of abandoning one instrument and taking-up others which from time to time may be elsewhere proved or supposed to be superior—assuming, of course, that a real interest is felt in the adoption of the most efficient—will ultimately be found greater than that of duly qualifying ourselves to form an independent judgment.

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* *Ante*, p. 647.

The principle of investigating and experimenting for ourselves is not only *per se* satisfactory, but also affords the readiest and surest means of obtaining the desired information. Accordingly, its importance has long been recognized, and its necessity has been more than once prominently set forth. A detailed and weighty statement of the case is contained in the memorial addressed in 1863 to the President of the Board of Trade by the British Association,* which deserves to be attentively studied; not only on account of its valuable practical suggestions, and of its containing a complete resumé of the then state of knowledge in this country respecting fog-signals; but also because it had its origin, not in any desire on the part of scientific men for mere abstract information, but in an application made to them by the Chamber of Commerce and several of the leading merchants of Belfast, and it is therefore a correct indication of the high importance attached to the subject by shrewd men of business interested in shipping and commercial pursuits.

Reference has already been made to some experiments upon bells by the engineers of the Corps des Ponts et Chaussées; and I learn from M. Reynaud that experiments upon various fog-signals, which were in progress in 1870, and were interrupted by the war, will be resumed as soon as the necessary arrangements for the purpose are completed.

In the United States, the subject has been one of constant interest to the Lighthouse Board since its organization in 1852; and, since 1866, a permanent Committee on Experiments has been established, and is presided-over by Professor Henry, Director of the Smithsonian Institution, Washington. No results of their investigations have as yet been published, but Admiral Jenkins, Naval Secretary to the Board, has obligingly promised to communicate them to me when the Committee's Report is made. With reference to those investigations, Admiral Jenkins states:—" We are aware that we have so far neglected the " the most important experiment in regard to these instruments, viz., " that of their power and effect during fogs of greater or less density. " All our experiments so far have been made in good clear weather, and " in several cases with a view to devise some sure and practicable means " by which to transmit the sound to the desired direction with the aid " of sounding-boards and other methods of reflection. We propose to " enter upon a more regular and systematic plan of experiment with " different kinds of fog-signal instruments at no distant day, the main " feature of which is designed to be that they shall be made during the " actual existence of fogs, and under the influence of different forces " and directions of the wind. We have a large number of fog-signals " in operation, and more are being set up. *The demand for these aids " to navigators has been so pressing that we could not wait to determine " which is really the best, but endeavoured to make up for that by intro- " ducing some of all the different kinds, so far as they are adapted to*

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* Report of the British Association, vol. xxxii., p. 105 *et seq.*

"*special localities*."[*] Since the organization of the Lighthouse Board in 1852, there have been established on the coasts of the United States not less than 14 steam-whistles, 3 steam-syrens, and 16 horns and trumpets, besides lighthouse bells, auxiliary trumpets, and the bell and horn uniformly supplied to and used on board of their light-vessels. When it is remembered that within the same period—during many years of which, unexpected difficulties must have been caused by the civil war,—the Board was also occupied with the labour of entirely reorganizing the lighthouse service, and of effecting general and extensive improvements in the buildings and apparatus of the lighthouses, which previously were in a wretched condition,[†] it will be cordially admitted that our American kinsmen have herein set an example which is as creditable to their energy as it is worthy of imitation.

I have not heard that any special investigations and experiments have been made in the Dominion of Canada; and it is extremely probable that the similarity of the meteorological and climatic conditions of the Canadian provinces to those of the Northern States, as well as the frequent opportunities afforded by proximity and constant intercourse, of exchanging information upon the subject of fog-signals and of attentively observing their results in practice, rendered separate experiments unnecessary. The Department of Marine and Fisheries has intelligently appreciated the value of the trumpet and the steam-whistle—the latter of which, indeed, was first employed in New Brunswick—and the coast is now well supplied with those signals, additional ones being also from time to time established wherever found requisite.

Now, it may be confidently affirmed, and the assertion will be corroborated by the experience of all who are acquainted with the nature of experimental investigation, that in this country, differing as it does from America in every particular of its climate, meteorology, and local phenomena, no mere study of the results obtained from experiment there, and no amount of observation, however painstaking, of the working of the fog-signals there established—even supposing that such study and observation were diligently followed-up—can afford the same clear insight into and thorough mastery of the whole subject as would be obtained from a scientific and searching investigation, rigorous, systematic, and comprehensive, conducted on our own shores. Not only is this true in reference to the peculiar and local considerations involved, but it applies with especial force to the innumerable practical details which such an investigation must always elicit, a knowledge of which cannot be acquired at second-hand. Even the particular manner in which a result comes out frequently affords a valuable clue to something beyond; and it is incontestable that in this, as in every other department of experimental research, the multiplication of independent centres of observation powerfully assists the attainment of the desired end. Whilst, therefore, investigations conducted in this country would have a special value to ourselves, as being made under meteorological and local conditions identical with those under which their results were to be applied in practice, and as affording an otherwise unattainable acquaintance with details; they would at the same time be of important general utility, by supplementing the observations of others and thus contributing to the common stock of human knowledge.

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[*] Letter to the Author, 13th November 1871. The italics are my own.

[†] Report of the United States Lighthouse Board, 1852.

A careful and diligent research, embracing a great number of various sources of information upon the point, and in which neither time nor trouble have been spared, has failed to discover a trace of any experiments whatever having been made in this country in reference to the effective range of fog-signals. There have been a few experimental competitive trials of some instruments; but the purpose for which they were made appears to have been simply that of determining which could be heard furthest in calm and clear weather. Such a trial, if made with the view of weeding-out those which would not come up to a certain standard, in order to reduce the number to be thereafter subjected to experiment with reference to their effective range as fog-signals, would be useful in its own way. I do not at all seek to undervalue it. What I desire to point out is this:—that to regard the results obtained as being any test of the latter quality, would be a mistake. A naval officer, under instructions to report upon the efficiency of two different apparatus for lowering boats in a sea-way, and wishing to ascertain in the first instance which of them could be handled and put in operation in the shortest time, might with perfect propriety experiment upon this point in the East India Docks; but if he should regard the experiment thus made as being a test of their relative or absolute value in reference to their intended purpose—that of safety and efficiency in a rough sea—and should report accordingly, he would commit a precisely similar error.

It way be asked why, if this be the case, has the action of the United States Lighthouse Board been mentioned in terms of commendation, seeing that they also have hitherto neglected to make experiments during fogs? The reply is:—first, that their fine-weather experiments appear to relate to the best means of transmitting sounds in a given direction by means of reflectors and other appliances, and to the mere mechanical details of the instruments; and at any rate are not regarded as determining the effective range of the instruments, the necessity of special experiments for that purpose being fully recognized: and, secondly, that the sole cause which has prevented the Board from experimenting upon that matter is, that their time has hitherto been fully occupied in actually establishing, at many different points on the coast, the best available instruments of different kinds, to meet the pressing demands for fog-signals.* The two cases are totally dissimilar.

Having thus advocated the institution of inquiry and experiment, with a view to the further development of the fog-signal system in this country, it will naturally be expected that I should be prepared to state the nature and extent of the investigation recommended; and this I shall now proceed to do.

(A). The first point calling for examination is that respecting the relative densities of fogs, and it will be necessary to obtain some standard by which these may be determined.

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* *Ante*, p. 670.

In the treatise on fog-signals already quoted-from,* Mr. Cuningham suggested that an optical test should be applied to this purpose, by observations respecting the distance at which coloured poles ceased to be visible. In a subsequent paper† he states that a series of his proposed experiments was tried, under the auspices of the Commissioners of Northern Lighthouses, at certain stations on the Scottish coast. "The means supplied," he says, "were exceedingly simple, " being a pole coloured red, white, and black, in equal divisions. The " direction to the light-keeper was in fog to observe the pole (which " was to be placed horizontally), and by retiring gradually from it, to " report at what distance *in feet* each colour disappeared from the eye, " so as to establish which colour was most visible in fog." From the returns of observations at eleven stations for six months, it appears that the distances in feet at which the colours ceased to be visible, averaged as follows:—White 230, Red 251, Black 278. The maximum and minimum distances are not given in Mr. Cuningham's statement, but it is probable that they varied considerably, according to the density of the fog. The mean results are only valuable in connection with the general ratio of visibility of the three colours, and also as showing that the distances are not too great to be conveniently measured-off.

(Aa). A series of observations, based upon this method, should be made. For the purpose which I have in view, it will be sufficient to to make them at one station; and, for the sake of accuracy, it will be well to have two poles and six observers (two to each colour).

(Ab). Simultaneously with these, and in the same locality, observations will be made upon the maximum distances at which sounds can be heard. The instruments to be employed are the gun, the trumpet, and the whistle. The experiments should be tried in flat calm, and there should be as little disturbance as possible from other noises. The phonic signals will be made separately, in regular order, with prearranged uniform intervals of such duration (probably 3 or 5 minutes) as may be found most convenient. The order of sequence in which the phonic signals are made is of no importance: the gun may come first; then, after the fixed interval, the whistle; then, after the same interval, the trumpet; and then, after a double interval, the gun again, the series being repeated as many times as the duration of the fog will permit. The pole-observers will be told-off in three groups, two observers for each colour; and, at the time of sounding of each signal, they will independently note the distance at which the colours are lost. The positions of the sound-observers will be previously marked-out, at regular intervals, at distances of not more than a quarter of a mile apart, and there should be two observers at each point. Their duty will be to note, independently of each other, whether they hear each signal, and what is its character and quality. A subsequent examination of their returns will give with tolerable exactness the range of each signal.

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* *Ante*, p. 647.

† March 1866. Trans. Roy. Scottish Soc. of Arts, vol. vii.

(Ac). The foregoing experiments are to be accompanied by careful barometric, thermometric, and hygrometric observations, at a suitable station in the same locality, in order to establish an additional test of fog, and to afford a means of accounting for any discrepancies which may appear in the results when tabulated.

The intention of this series of observations is, to determine whether there is really any definite and constant relation between the effect of fog on the visibility of an object and the audibleness of sound. Such a relation having been, if possible, determined, its practical value will be very great. The test of vision will not only be of constant usefulness in the succeeding experiments, but it will afford a means of supplementing them by observations upon the efficiency of signals already established at different stations, and will lighten the expense to be incurred, by enabling us to take advantage of such instruments as the large bells at the Start, the South Stack, and on the Irish coast, for the purpose of experiments. Without such a standard measure for comparison, these could not be made available for the general series, since it would be impossible to compare results obtained from them with those obtained from that series. The expense of fitting-up even one such bell for the general series would be considerable, whereas three or more would be rendered available by applying the standard test to the fogs in which they were tried. I therefore consider this preliminary investigation to be both important and necessary.

(B). The second series of experiments relates to the determination of the question, whether sounds to be sent against the wind should be originated near the level of the sea, as is usually considered desirable; or at an elevation, with a suitable depression of the principal phonic ray, in accordance with what has been above proposed.* This series, having no relation to the question of fog, will be made in clear weather, a mode of proceeding which will save much time, as regards both the opportunities of making the experiments and the facility with which distances can be determined. The experiments will be made during the strongest available winds, and as directly to windward as possible. The force of the wind will be ascertained simultaneously by the anemometer and by the usual estimation according to the Beaufort scale. The double mode of observation is not intended to determine the relation between the actual pressure of the wind and its estimated force, a question upon which there is considerable difference of opinion. Colonel Sir H. James, R.E., has given a table of pressures which he considers equivalent to the numbers on the Beaufort scale;† and a popular method of approximation to the pressure in lbs. per square foot consists in halving the Beaufort number and squaring the quotient. I am indebted to the kindness of Mr. Scott, F.R.S., Director of the Meteorological Office, for pointing out that the conversion of the Beaufort numbers into equivalent pressures is not as yet positively determinable by any fixed rule, a fact which has been verified by numerous comparisons of estimated force with corresponding anemometrical observations. But both methods of notation will be adopted in the experiments now under consideration, in order that nothing may be omitted which may be useful in checking and comparing the results obtained.

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* *Ante*, p. 664.

† "Instructions for taking Meteorological Observations," p. 31.

(Ba). For the signals in this series it will be sufficient to employ the gun, the trumpet, and the whistle. Two of each will be required; one placed 15 or 20 feet above the sea-level, and the other at an elevation of 100 or 150 feet. Bearing in mind the object of this series, which is to determine the most efficient method of overcoming the resistance offered by the wind to sound generally, as well as to the sound of certain particular types of instrument, it will be apparent that nothing strictly in the sense of a competitive trial between the different instruments is intended. The arrangement of the signals in groups, therefore, is made merely in order that advantage may be taken of the occurrence of a suitable wind, and the position and distance of the observer, to obtain a test of them all. The order of sequence of the different instruments is not in itself important, but, when once commenced, it must be adhered-to. The following appears to be the arrangement best calculated to attain the desired end. Lower gun. Interval 1 minute. Upper gun, horizontal. Interval 4 minutes. Lower gun. Interval 1 minute. Upper gun, first depression.* Interval 4 minutes. Lower gun. Interval 1 minute. Upper gun, second depression. Interval 4 minutes. Lower whistle, blast 10 seconds. Interval 50 seconds. Upper whistle, blast 10 seconds. Interval 1 minute 50 seconds. Lower whistle, blast 5 seconds. Interval 55 seconds. Upper whistle, blast 5 seconds. Interval 2 minutes 55 seconds. Lower trumpet, blast 10 seconds. Interval 50 seconds. Upper trumpet, horizontal, blast 10 seconds. Interval 1 minute 50 seconds. Lower trumpet, blast 10 seconds. Interval 50 seconds. Upper trumpet, first depression, blast 10 seconds. Interval 1 minute 50 seconds. Lower trumpet, blast 10 seconds. Interval 50 seconds. Upper trumpet, second depression, blast 10 seconds. (End of group.) The interval between the groups will depend upon whether the observer is able to shift his position (as in the case of his being on board a steamer), in which case sufficient time must be allowed for the move, and the group will be repeated upon the interchange of a pre-arranged signal. If observers are stationed at various points previously selected, the interval between the groups need not exceed 10 minutes. The question of the position of the observers will be considered hereafter.

(Ba *a*). A modification of this series may be advantageously made if the whistles are furnished with sound-concentrators or reflectors. In this case the principal phonic ray of the upper whistle will be sent first horizontally, and then at the two depressions, as arranged for the gun and the trumpet. It will be desirable, however, to try the naked whistle in each group, and this will require a special interval to allow time for the removal and re-fixing of the reflector. This interval can be filled-up with an intermediate group of the gun and trumpet signals. It is unnecessary here to enumerate all the details of these groupings, the character of the series having been sufficiently indicated. It is, however, to be borne in mind, that no time is to be left unemployed if it can be turned to account, since the occurrence of a strong and favourable wind is an opportunity not to be wasted.

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* The actual amount of depression to be given to the signals will depend upon the force of the wind at the time, and will be noted by the person in charge of the signal. The first and second depressions will be the minimum and maximum limits required, as ascertained by calculation.

(Ba *b*). The duty of the observer or observers will be, to note the effect of each signal of the series, comparing the relative strength of those made by the same description of instrument. The sound of the lower gun, for example, is to be described according to its strength and general character, and that of the upper gun is to be compared with it and described accordingly. The whistle and trumpet will each be entered in a similar manner. It cannot be too carefully remembered that this series is intended as a competitive trial, not between the gun, trumpet, and whistle, but between the instruments of each description at the upper and lower stations, and also (if the whistles are furnished with reflectors) between the lower whistle when so furnished and when naked, and between the upper one when so furnished and when naked.

(Bb). Another duty of the observers will be, to test the precision with which the local source and direction of the signals can be determined, and the method of doing so cannot be better described than in Mr. Alexander's words. "Uniformly the fainter the sound, the " more vague is its presumed direction, while in proportion as its " intensity increases, it can be ascribed within small and smaller " limits to a particular quarter. In applying this test, the best mode " I could devise was to close my eyes just before the moment when " the sound was expected, to turn round two or three times in order " to confuse and lose as much as possible any conscious orientation, " and then when I heard the sound to point, still with eyes closed, in " the direction along which it seemed to reach me. As the station " itself was visible from where I stood, the deviation of the supposed " from the true line was readily observable."*

This series will be repeated whenever an opportunity occurs, until a definite conclusion is arrived-at. The value of the result so obtained will be fully appreciated in the concluding series of experiments, which is intended to determine the effective range of the various instruments. As this is a point which will be hereinafter referred-to, I shall at present merely observe that this series is essentially necessary.

(C). The third series of experiments relates to the trial of new instruments and appliances, and of various modifications of existing ones. It is very far from my intention to advocate, and I desire to avoid even the appearance of advocating, any investigation of a purely speculative character, or having for its object the originating of new inventions—a thing which in this country is regarded with perhaps not altogether unreasonable distrust. There are, however, some instruments not hitherto employed as fog-signals, which appear to possess sound and power suitable to the purpose. There are also some questions connected with the distinctive character and quality of sound in relation to the penetration of fog, which ought not to be overlooked in a practical inquiry. And there are certain modifications and details of existing instruments, directly and intimately connected with the efficiency of those instruments, and which must therefore be examined. The arrangements necessarily made for the principal line of the present investigation afford facilities for the prosecution of inquiry respecting these matters, of which it will be well to take advantage.

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* "Report on Fog-signals," *ubi sup.*, p. 102–103.

(Ca). Under the first subdivision are included organ-pipes; and since, as is well known, the largest wooden pipe of an organ can easily be sounded with the breath, it is worth trying what effect would be produced by a powerful blast of air, and also (which is to some extent connected with the second subdivision) whether a battery of such pipes could be arranged which should produce a very compound and penetrating sound. If the result be sufficiently favourable, they will be noted for experiment under series (D). This subdivision also includes such instruments as Humphrey's percussive whistle and Wigham's gas-gun. The latter has been experimentally tried by the Commissioners of Irish Lights, and is favourably mentioned by Captain Hawes, who says:—"Instead of gunpowder guns we have been trying an "invention of Mr. Wigham's, by which gas is used for charging and "firing heavy guns. The advantages he claims for his system are, "that, while the sound was as great as necessary for fog-signalling "purposes, the flash is much brighter than that proceeding from an "ordinary cannon, which is a consideration of much moment."* This instrument, if found to possess sufficient effective range, would be a valuable addition to fog-signals, since it would probably be free from the objections already stated in reference to guns on the score of expense and of the difficulty of quick repetition. It will therefore be fully tested, and its effective range ascertained as hereinafter described. The percussive blast proposed by Mr. Humphreys† will also receive attention, his own experiments having proved that it produces a very distinctive and characteristic sound from a whistle.

(Cb). The second subdivision, relating to the special penetrating power of certain qualities of sound, although partially covered by trials of instruments in the other series of the general inquiry, is of sufficient importance to require more particular investigation. It has already‡ been seen to be probable that there may be an analogy between sound and light in the effect of fog upon them, and this probability will be strengthened if series (A) should establish a definite relation between the stifling or deadening of the one and the obscuration of the other. The clue thus obtained is to be followed-up, by experimenting upon the effect of combinations of sounds in a single phonic ray, and observing which of the sound-waves has the greatest penetrative power. It is extremely probable that this will be found to vary in a tolerably well-defined manner with the different descriptions of fog. Should this prove to be the case, a further clue will be afforded for investigation, since certain kinds of fog have a definite modifying effect upon transmitted light; and the result may be to indicate a practical means of varying and combining certain qualities of tone according to the character of the fog to be penetrated. The investigations under this subdivision will have also a practical bearing upon the use of the syren, as already indicated.*

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* Report to Commissioners of Irish Lights, 10th April 1872.

† *Ante*, p. 658.

‡ *Ante*, p. 663.

(Cc). The third subdivision is intended to relieve series (D) by preliminary experiments upon modifications and details of various instruments; a service the utility of which will be hereafter apparent.

(Cc *a*). Mr. Alexander's experiments upon the most efficient pressures of steam for whistles have been already mentioned,† and it will be proper to devote some care to the determination of this matter in its relation to the size of the whistle. The important practical bearing of the question is forcibly illustrated in the case of the steam-whistle about to be established at Cape Race, N.F. It was at first intended to use at that station a 12-inch whistle. I find, however, on reference to the papers at the Board of Trade, that early in the present year it was recommended by the engineering advisers of the Colonial Government that a 10-inch whistle should be substituted, on the ground that experience had proved that the latter gave a more powerful blast with the pressure intended to be used; and the alteration thus proposed has been sanctioned and will be carried-out. In connection with this point, it may be mentioned that Mr. Bailey informs me that his "steam-roarer" is, by adjustment, suitable for either high or low pressures. Its capability in this respect will be investigated. It is also a question of interest, and will form a proper subject for experiment, whether the effect of a given quantity of steam can be most advantageously applied to one large whistle or to two or more smaller ones. The most suitable and efficient pressures for trumpets and syrens will also be tried and ascertained.

(Cc *b*). The uniformity of sound of Holmes's trumpet over a horizontal arc of 90°, a property of great value in certain cases; and Brown's syren-trumpet above mentioned, which comes to us recommended by the opinion of Professor Henry; will also be carefully tested.

(Cc *c*). Reflectors and sound-concentrators are included in this subdivision. Among the instruments to be experimented-upon are Cowper's elongated reflector and Stevenson's holophone. From both of these, good service may be anticipated, provided that the effluent steam can be prevented from smothering the sound. Whilst upon this subject, it may be observed that although parabolic reflectors are frequently recommended, and in many cases may doubtless be applied with considerable practical advantage, yet it should not be lost sight of that the principle of the reinforcement of sound by resonance, so admirably illustrated by Tyndall,‡ is of very great importance, and deserves investigation with reference to its applicability to the purposes of fog-signalling.

(Cd). A fourth subdivision will consist of anemometrical observations, having for their object the determination of the different velocities of the same wind at different heights, when blowing over a level surface. These observations will supplement our at present imperfect acquaintance with the subject, and have a direct practical bearing upon the experiments (Ba) and (Ba *a*) relating to the projection of phonic signals to windward.

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* *Ante*, p. 660. † *Ante*, p. 660.

‡ Lectures on Sound, *ubi sup.*, p. 171–177.

The foregoing four subdivisions are, for convenience of reference, classed as a series, although in point of fact they are not to be strictly regarded as such, but may be conveniently made on various occasions as opportunity offers; and the fourth subdivision (Cd) will properly precede series (B), in order that as much advantage as possible may be taken of the results for practical use in that series.

(D). The first series (A) having afforded the means of measuring the density of a fog, and the second (B) having determined the best method of employing the sound of three principal and typical instruments when sent to windward, the way is now cleared for the fourth series of experiments, the object of which is to determine the effective range of the instruments employed as fog-signals, viz., guns, trumpets, whistles, syrens, bells, and gongs.

(Da). The course to be pursued in the carrying-out of this series is comparatively simple, but the series will extend over a considerable period of time, in order that opportunity may be afforded for the testing of all the instruments in the densest fogs with the heaviest winds—in fact under the most trying and adverse conditions. The density of the fog, the force of the wind, the amount of sea-disturbance, and the barometric and other meteorological memoranda, are to be noted at the signal-station or other observatory; and the amount of local noise is to be noted at the observer's station. If the latter be situated on land, or at a fixed point, some means must be arranged for producing as nearly as possible the same amount of local noise as would accompany a paddle-steamer under full way in a heavy sea—a problem the solution of which, although indispensably necessary, is not difficult; and, as it will afford an interesting exercise of inventive ingenuity to others, I refrain from at present pointing-out the means by which it may be effected.

The tests for each description of instrument will be kept perfectly distinct, experimenting thoroughly on one at a time; and it is to be steadily borne in mind that these tests are absolute, not relative, nor in any way competitive as between different instruments. All the instruments (excepting gongs) will be tested low down as well as high up; because there are many localities requiring the establishment of fog-signals but not admitting of the signals being placed in any but a low situation, and it is therefore indispensably necessary to determine the effective range of an instrument so placed.

The duty of the observer will be, to note the amount of local noise, and the audibility and character of the sound of the signal; and, if he be at a point whose distance is not already determined, he will note his distance from the signal by cross-bearings or other suitable means.

The observations will be repeated until the maximum distance at which the signal can be heard is ascertained. If the conditions of wind and fog are also at their maximum of obstruction, the effective range of the signal is *ipso facto* determined; and, after this has been conclusively settled by a second trial, the third repetition of the experiment (which is desirable as a check upon the former ones) will be deferred until a similar crucial test—the opportunities for which are necessarily unfrequent—has been applied to the other instruments.

It is here not unimportant to point-out the relation which the previous series of experiments bear to this one, and the value, in connection herewith, of the results which they aim at establishing. The concurrence of the densest fogs with the greatest force of wind, although not so rare as is generally believed, is yet not so frequent as to justify the use of those opportunities of determining the effective range of fog-signals, for any experiments which can be conducted under conditions of more frequent occurrence. The value of the standard test of density (A) in affording facilities of experimenting upon instruments already established at different stations, has been pointed-out. Its use in relation to the present series is this:—that it affords the means of ascertaining whether any particular fog is denser than others which have been experimented-upon—a thing of the utmost importance when it is remembered that the object of this series is to determine effective range. The experiments (B) upon the best method of projecting sounds to windward, will allow of the trial of instruments placed and worked in the most suitable manner, and will also indicate the preference to be given to certain instruments for certain situations. For example—to assume a case—it may be found that the effective range of the whistle is sufficient whether it be situated low down or high up, owing to the special power of the instrument, but that the trumpet only attains a 3-mile range when situated at a height. In this case the use of the trumpet for 3-mile ranges would be at once limited to places where it could be so placed, while the whistle would be suitable for any situation; and the information thus obtained would be of great value in the tests for effective range, by saving the unnecessary trial of the trumpet at a low level. Again, the preliminary experiments in subdivision (Cc) will settle many questions relating to the pressures best proportioned to certain dimensions of instruments, the most economical application of those pressures, the best methods of reinforcing or directing sounds, together with other matters, the trial of which in the present series would involve the loss or misuse of valuable opportunities required for experiments which can only be made on special occasions of dense fog and high wind combined.

(Da *a*). The guns to be tried are 18-pounders, one of iron and one of brass, with a charge of 3 lbs. of powder. This calibre and charge, being what is adopted in practice on our coasts, is the most proper to test. If, however, the results obtained show that the effective range of these guns is less than 3 miles, but at the same time afford indications warranting the expectation that an increase in the size and charge would produce the required effect, a 24-pounder with a charge of 5 lbs. of powder, as recommended by Sir Alexander Milne, should be tried. It must however be remembered, that all that has been previously remarked * in reference to the difficulty of working an 18-pounder with the staff at present assigned to gun-stations, will apply with additional force to a heavier gun, and that the working cost of the signal will be increased by the use of a heavier charge of powder.

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* *Ante,* pp. 649, 667, 668.

Should the preliminary trials of Wigham's gas-gun (Ca) be satisfactory, its effective range will be thoroughly tested in this series.

(Da *b*). The trumpets to be tried are Daboll's and Holmes's, to which may be added any others that have satisfactorily passed through the trials in series (C). Both the second and third order Daboll's trumpet will be tested, since one may be found effective at one range and the other at another.

(Da *c*). Whistles will be tested naked, as well as in combination with the most efficient sound-concentrators, the employment of the latter being probably not suited to every situation.

(Da *d*). Syrens will be similarly tested; and, if the experiments in subdivisions (Cb) and (Cc *a*) warrant it, they will be tried in combination with each other and with the whistle. Brown's syren-trumpet, if found satisfactory in subdivision (Cc *b*), will also be tested for effective range.

(Da *e*). Experience does not favour the belief that the effective range of bells is great. Nevertheless, whether great or small, it must be definitely ascertained. These instruments are already in use at so many stations, that experiments upon their range will be most conveniently made at some of the stations which offer peculiar advantages by reason of their admitting of the previous ascertainment of the distances at which observers can be placed. And, as bells are employed chiefly at rock lighthouses, and are therefore nearly all subject to uniform conditions of weight and elevation, there is a special propriety in experimenting upon them *in situ*.

(Da *f*). Gongs will be tested either from a light-vessel (the situation of many of which is suitable to the purpose) or from a similar elevation elsewhere. They will be sounded both by striking and by friction, and these again will be applied both continuously and at intervals, until the greatest effective range is obtained.

(Db). The facility with which the local source and direction of each signal can be determined, will be also a matter for experiment in this series, as well as in series (B).

The result of this series of experiments will be to arrange the fog-signals in groups according to their effective ranges, which will determine the suitability of the instruments for different purposes and situations. Some (it is hoped) will be found to possess the ranges requisite for great sea-signals or danger-signals; others will answer for minor signals, such as are suited to points which cannot be reached by a vessel without previous warning of her whereabouts from a sea-signal, or for channels and harbours. From the various instruments composing each group, it will easily be possible to choose those which are most effective or economical, or whose capability of conveying distinctive indications renders them peculiarly suited for alternation with others on a long coast-line. In fact this series will afford opportunities for a discriminating selection and application of instruments for fog-signals, such as never before has been possible.

(E). The subject of the position of observers has been more than once mentioned, and requires consideration. Theoretically, of course, the best situation for the observer is on board a steamer, which not only will enable him to shift his distance and bearing as required, but also will furnish the requisite amount of local noise. Some of the observations can without difficulty be made in such a situation, provided that the steamer is sufficiently powerful and sea-worthy to face a gale of wind; and probably the experiments of series (B) will be most advantageously observed in this manner. But it is not so certain that the observations to be made during fogs, and especially those of series (D), can be so conducted; whilst it is quite clear that those of series (A) must be made from fixed points. My own preference is for fixed points for series (A), (C), and (D), and a steamer for series (B). Fixed points can be selected, their distance and bearing ascertained, and any other necessary arrangements made, at leisure, before the experiments begin. Whether one method, or the other, or a combination of both, be adopted, the locality in which the experiments are to be carried-out must be selected accordingly. It may be here remarked, however, that the experiments in series (A) need not necessarily be made at the same place as the others. All that is requisite for that series is a sufficient extent of level ground, or of smooth and shallow water, with no hills round about to produce echoes, in some situation where there is very little disturbance from other noises, and plenty of fog. Snow, sleet, and thick rain, are phenomena not sufficiently rare in this country to require special care in the selection of a site, as it is not likely that any spot to be chosen will be unsuitable by reason of their too long absence.

(F). With regard to the person to whom the conduct of the investigation should be entrusted, I am decidedly of opinion that an officer in Her Majesty's Navy would be the most suitable. It is also from the Navy that I would recommend the selection of men for the work, their employment upon it being made the reward of intelligence and good conduct; a distinction which, with the addition of a small sum to their pay, would create an active competition for the service. For special scientific advice, recourse should be had to some person appointed by the Government department under whose auspices the investigation is made, and the President of the Royal Society might be invited to recommend some one for the appointment.

Such, then, is the general scope and plan of the investigation recommended. It will be observed that I propose to deal as much as possible with existing instruments, already applied to the purpose of fog-signals, or capable of being so; and that I have avoided any experiments tending to deprive the proposed investigation of that practical character which it is desirable to maintain. Nevertheless, if any invention of great *primâ facie* merit appeared, it ought to have a trial, it being obviously for the benefit of the inquiry that the most efficient instruments should be examined and tested.

The whole of the experiments proposed have a definite object, which is fully stated in each case. If notwithstanding, it should be objected that they are not of a practical tendency, it will be necessary to inquire whether the information in each case aimed-at is or is not desirable? If it be admitted that it is—and this will hardly be denied—the question must then be asked, whether we are, at present, definitely and certainly in possession of a single one of the facts sought to be elicited? Is there any person who will undertake to affirm that we know in what respect, and to what extent, one fog differs from another in obstructing the transmission of sound? That there positively is no better way of driving a signal against the wind than by going on indefinitely increasing the power of the instruments now in use? That we are already in possession of the best possible instruments, or have any definite knowledge as to which really is the best instrument? That we even know (say to within a mile or two) at what distance our present fog-signals can be heard to windward in the heaviest thick and stormy weather? That, in short, our position, as a maritime nation possessed of the most wide-spread commerce and the largest mercantile marine in the world, is at the present moment, with respect to fog-signals, so thoroughly satisfactory, that an investigation such as now recommended is superfluous, and that money expended thereon would be money wasted?

It is not intended to assert that the proposed experiments are perfect in all their details. Modifications and improvements may doubtless suggest themselves. But it may fairly be maintained that the general principle and outline indicated are correct; and that such an investigation, if carried-out as intended, will place us in possession of a vast amount of practical and valuable information which we ought to have, of which we are at present destitute, and which without such an inquiry we cannot hope to obtain.

Before concluding, I have a pleasing duty to perform, in expressing my obligations to the Admiralty, the Board of Trade, the Commissioners of Irish Lights, and the lighthouse authorities of Canada and the United States, for valuable information derived from their records, and for the ready courtesy with which that information has been placed at my disposal.

Finally, I would bespeak the indulgence of naval men for any technical errors into which I may have fallen in reference to matters appertaining specially to the nautical profession. Of those matters it is impossible to treat with the clearness and accuracy of a sailor. But I venture to hope that such errors, if they exist, will be viewed with the leniency due to a landsman who has been obliged to travel somewhat out of his own element in the earnest endeavour to promote knowledge upon a subject of great importance, affecting not alone the maritime service, but to a large extent also the interests of civilization and the welfare of mankind.

Evening Meeting.

Monday, May 20th, 1872.

ADMIRAL THE RIGHT HON. THE EARL OF LAUDERDALE, K.C.B., &c., in the Chair.

NAMES OF MEMBERS who joined the Institution between the 16th and 20th May, 1872.

LIFE.

Dunn, R. G., Captain 9th Regiment.

ANNUAL.

Burn, David B., Lieutenant 75th Regiment.
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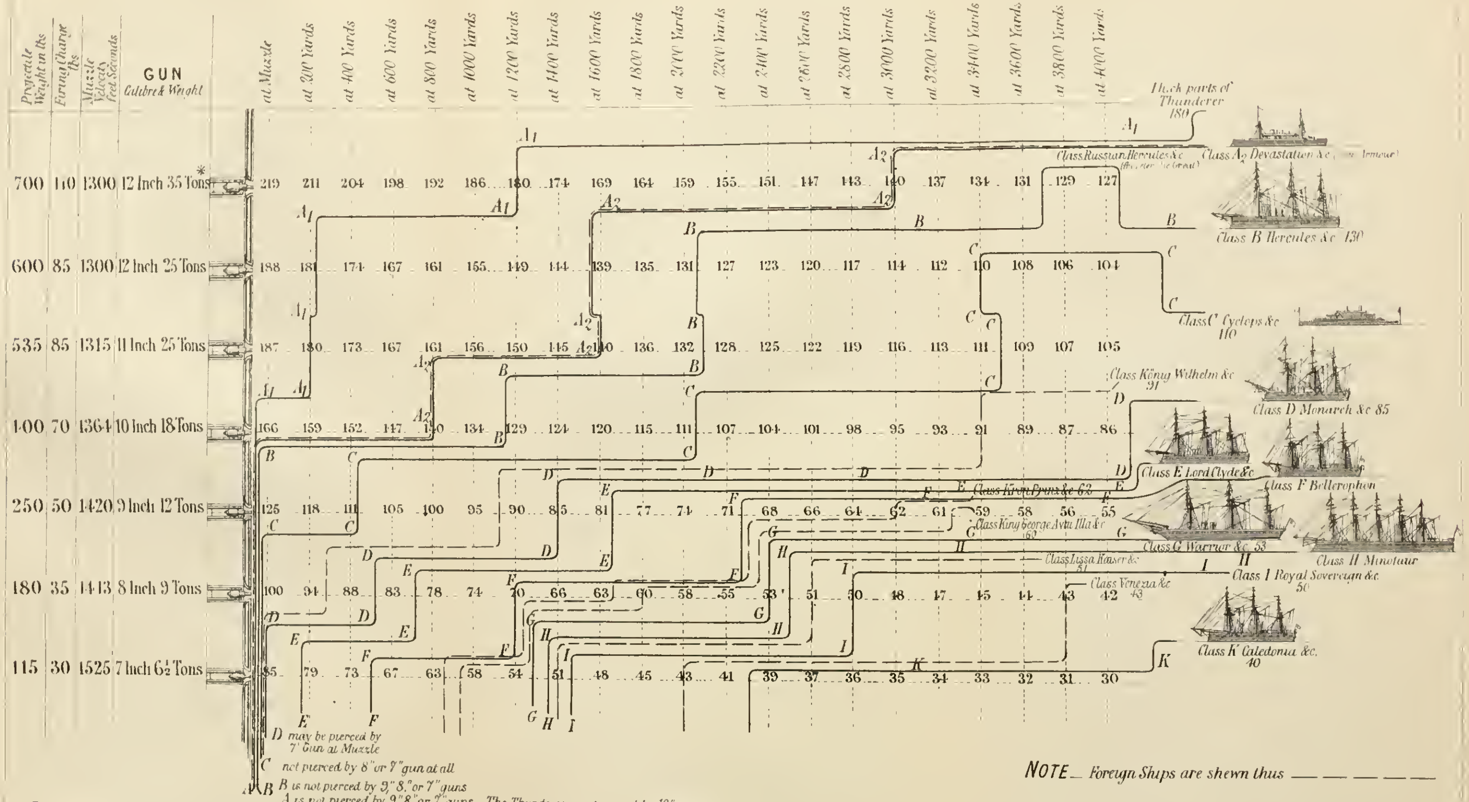
FIRING AT ARMOUR-CLADS REDUCED TO SYSTEM.

By Captain C. ORDE BROWNE, late R.A.

I TRUST that the title of my paper to-night may not seem to imply that I come forward prepared to suggest a complete system on which all firing at armour-clad vessels might be conducted, much less to endeavour to lay down the law on such a subject. While holding an appointment in the Royal Arsenal, it was my duty to describe the construction of the various projectiles adopted for the service, and I naturally endeavoured to add a few directions as to their use. I conceive that it is in no way invading the province either of Naval Officers or constructors, but the obvious duty of an artilleryman, to endeavour to arrive at the best method of using his guns against armour. He would in fact be hardly treating naval science with due respect, if he did not learn how to give an iron-clad vessel a reception suited to her character. Clearly, however, he should endeavour to obtain the opinions of those who have a professional knowledge of naval matters. Thus, while learning much from the numerous Officers of my own corps who came to the Royal Arsenal, I especially tried to profit by the visits of Gunnery Instructors of the Royal Navy and Royal Marine Artillery, as well as of French, Russian, Danish, and American Naval Officers. I only profess to have studied the question from an artillery point of view, and my aim to-night is to read a short paper leading up to a discussion in which valuable opinions may be

DIAGRAM

SHOWING PENETRATING POWER (i e energy per inch of shot's circumference) at certain ranges OF PROJECTILES FIRED FROM THE SERVICE HEAVY MUZZLE LOADING GUNS also lines traced to indicate THE RANGE AT WHICH EACH CLASS OF ARMOUR PLATED VESSEL MIGHT PROBABLY BE PIERCED by direct fire from each gun



Projectile Weight in lbs	Firing Charge lbs	Muzzle Velocity Feet Seconds	GUN Calibre & Weight	at Muzzle	at 200 Yards	at 400 Yards	at 600 Yards	at 800 Yards	at 1000 Yards	at 1200 Yards	at 1400 Yards	at 1600 Yards	at 1800 Yards	at 2000 Yards	at 2200 Yards	at 2400 Yards	at 2600 Yards	at 2800 Yards	at 3000 Yards	at 3200 Yards	at 3400 Yards	at 3600 Yards	at 3800 Yards	at 4000 Yards
700	110	1300	12 Inch 35 Tons*	219	211	204	198	192	186	180	174	169	164	159	155	151	147	143	140	137	134	131	129	127
600	85	1300	12 Inch 25 Tons	188	181	174	167	161	155	149	144	139	135	131	127	123	120	117	114	112	110	108	106	104
535	85	1315	11 Inch 25 Tons	187	180	173	167	161	156	150	145	140	136	132	128	125	122	119	116	113	111	109	107	105
400	70	1364	10 Inch 18 Tons	166	159	152	147	140	134	129	124	120	115	111	107	104	101	98	95	93	91	89	87	86
250	50	1420	9 Inch 12 Tons	125	118	111	105	100	95	90	85	81	77	74	71	68	66	64	62	61	59	58	56	55
180	35	1413	8 Inch 9 Tons	100	94	88	83	78	74	70	66	63	60	58	55	53	51	50	48	47	45	44	43	42
115	30	1525	7 Inch 6½ Tons	85	79	73	67	63	58	54	51	48	45	43	41	39	37	36	35	34	33	32	31	30

D may be pierced by 7" Gun at Muzzle
C not pierced by 8" or 7" gun at all
B is not pierced by 9," 8," or 7" guns
A is not pierced by 9," 8," or 7" guns. The Thunderer is not pierced by 10" gun.

NOTE — Foreign Ships are shewn thus — — — — —

EXPLANATION.

The guns being shewn in plan, the dotted lines across their front indicate intervals of 200 Yards along the range, numbered from the guns' muzzles up to 4000 yards. Opposite to each is registered the figure indicating the penetrating power at each 200 yards. Thus, if the "figure" required to pierce any ship's armour be known, the line or "trace" indicating at what range her armour might be pierced by the direct fire of each gun, is found by drawing lines through this "figure" or number wherever it occurs. Thus, if 85 foot tons per inch circumference will pierce the "Monarch," her trace must be drawn across the range of each gun at the figure 85.

* The penetrating "figures" for the 12 inch gun of 35 Tons (the so-called "Woolwich Infant") have not yet been actually determined, but are here estimated by Professor Bashford's rule, assuming a velocity of 1300 feet at the muzzle, with a charge of 110 lbs. The figures of the other guns are taken from Captn. Noble's table in the Extracts of the proceedings of the Department of the Director of Artillery. The Ships with their thickness of Armour, &c. (except Class C) have been taken from Mr. Reed's work "Our Ironclad Ships." The piercing "figure" of each class must not be taken for more than a probability. In some cases (such as that of the Warrior) it has been well established by repeated firing at Targets at Shoeburyness. In others, where no actual representative target has been tested, it has been deduced from the results obtained by firing at the structures most nearly resembling the armour in question. Even slight variations in conditions, however, may produce unexpected results, hence the diagram must only be looked upon as giving a general idea

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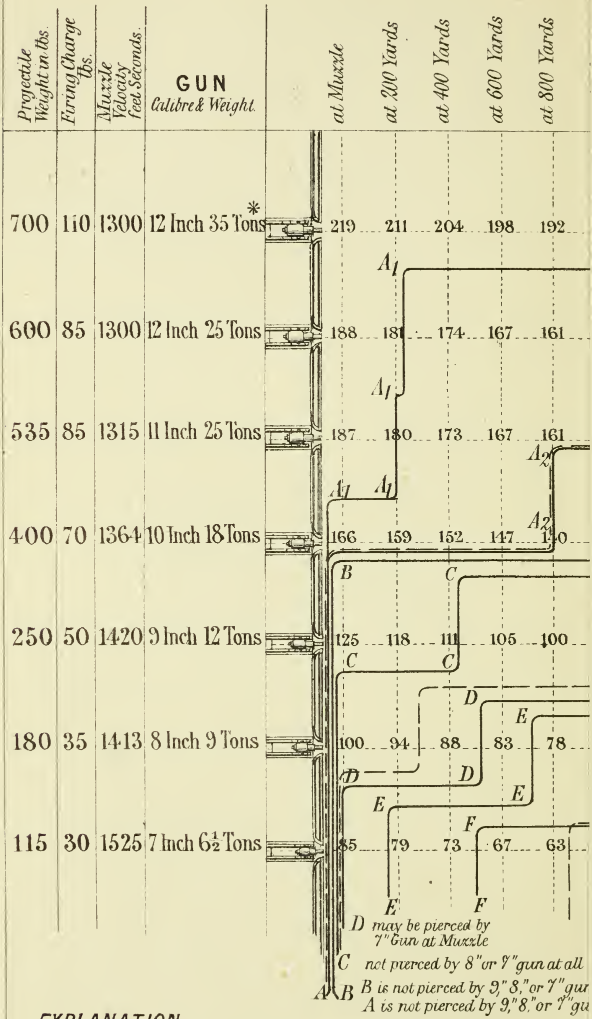

Projectile Weight in lbs.	Firing Charge lbs.	Muzzle Velocity feet Seconds.	GUN Calibre & Weight.	at Muzzle	at 200 Yards	at 400 Yards	at 600 Yards	at 800 Yards
700	110	1300	12 Inch 35 Tons *	219	211	204	198	192
600	85	1300	12 Inch 25 Tons	188	181	174	167	161
535	85	1315	11 Inch 25 Tons	187	180	173	167	161
400	70	1364	10 Inch 18 Tons	166	159	152	147	140
250	50	1420	9 Inch 12 Tons	125	118	111	105	100
180	35	1413	8 Inch 9 Tons	100	94	88	83	78
115	30	1525	7 Inch 6½ Tons	85	79	73	67	63

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elicited on the subject before us, believing that the time has come when it is possible to bring the firing at armour-plated ships to a more distinct system than has yet been done.

The large diagram before you (Pl. xxii), and the greater part of the matter in connection with it, was prepared by me for the concluding article of a series on "armour-piercing projectiles" for the *Engineer*, but the Editor kindly consented to the paper being brought forward here, and to keep back the publication of it till as nearly as possible the same date; further, he has sent us impressions of the diagram struck off to facilitate discussion.*

The large diagram before you furnishes a sort of picture of the state of armour and guns which the mind can readily grasp. I have no delicacy in saying this much for it, because very little indeed of it is my own. The mass of the "piercing figures" are copied from a table worked out by Captain W. H. Noble; the idea of connecting the "piercing figures" by lines so as to trace the limit to which vessels might advance, I have taken from Captain Ford, R.A.; a great part of the figures and facts concerning the vessels, I have, with Mr. Reed's permission, taken from his work "Our Iron-clad Ships;" the method of calculating the "piercing figure" of the 35-ton gun I owe to Professor Bashforth, who has also kindly checked the calculations I had made on his system. All I can claim as my own is the particular form into which the table is brought, and the working up of the information on which I have based most of the zigzag lines; and even in this I commenced on Captain Ford's researches, his professional duties making it impossible for him to pursue the subject further at present. Even now, I am far from satisfied with some of the zigzag lines, and am prepared to alter them on sufficient cause being shown to justify me in doing so.

You will observe that this diagram (though it should not be mistaken for a plan) is given in the form of a sort of distorted plan of a battery, containing one of each of our large muzzle-loading guns. A dotted line runs from the muzzle of each gun along an imaginary range, intersected by cross lines at distances representing intervals of 200 yards, commencing at the muzzle of the gun and terminating at 4,000 yards. At each intersection is registered the penetrating power, or what we may call the "piercing figure," of each gun at that range.

One word on the "piercing figure" of a ship's armour. I have generally considered the ship pierced when any portion of a projectile gets through the skin, so that it could be seen from the back of the target. This appears to be where the line is generally drawn, and when this takes place, it must be supposed that water can enter. This tells very heavily against the wood-built ships, in which by the way as there is *no skin*, the condition of *water entering* is taken. Mr. Reed intimates that on this principle many of these ships cannot be held practically to have more than 8 or 10 inches of real backing, the timbers in rear not being water-tight, hence the low estimate of some of their figures. It may be objected that, if not near the water-line, a penetration in this sense need not be at all a serious matter. This is quite true, but unless the line be drawn here it is very difficult to know where to take it, because a vessel might fight after shot had passed clean through her, and since a wooden ship might do the same, it is clear that, though all protection of the armour has not yet ceased, it has become a matter of degree, and in fact the vessel has passed from the condition of *security* into one of total *uncertainty*.

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* The Institution is indebted to the proprietors of the "Engineer," for permission to give a copy of the plate referred to.—Ed.

The penetrating power is assumed to be the energy per inch circumference of the projectile, expressed in foot tons, on the system carried out for the department of the Director of Artillery, as I have said, by Captain W. H. Noble. In order to register on this diagram the limit to which any ship may advance, without being liable to have her armour completely pierced by a single blow, it is only necessary to know her "piercing figure," in other words, the blow in foot tons per inch circumference of shot which will pierce her armour.

A list of the ironclads in the service (including many not yet completed) is appended, divided into classes according to the thickness of their armour (see Appendix); this list being in fact the one drawn up by Mr. Reed, with a few additions. The figures of ships which are selected as typical specimens of each class are partly taken from Mr. Reed's work and partly from photographs. I think they would add much to the value of the table for use on actual service by men unacquainted with the appearance of vessels.

The "piercing figure" of any class of ship being gathered from the results of experiments at Shoeburyness and elsewhere, as far as possible, it is only necessary to draw a cross line on the range line of each gun through such figure where it actually occurs, and, failing this, through the place where it would be registered if it were written in, and then join these cross lines by longitudinal ones, so as to form a continuous zigzag, showing at a glance the distance at which the class of vessel in question would become liable to be completely penetrated by each gun. This has been carried out on the table for each class as far as it could be done. The piercing figure is in some cases taken from the actual results obtained by firing at representative targets, and in others arrived at by inference, being deduced from a comparison of such experiments as seemed most nearly to the point.

It may be seen that the power of the 35-ton gun decreases faster than that of the other 12-inch gun, which throws a shorter and lighter projectile. This is clearly incorrect, but the extent of the error caused by the inconsistency is not serious. It arises from the fact that Professor Bashforth's system, on which the figures for the 35-ton gun are calculated, give results differing slightly from those worked out by Captain Noble.

Speaking generally, the zigzag lines shown on the table being obtained by some definite process which admits of explanation, contradictory statements ought to be supported by such facts as will outbalance those on which the table is based. In certain cases it is quite probable that this may be done. Some lines, it is true, such as that of the "Warrior," are established by trials, which the most voracious inquirer will find repeated to his heart's content in the records of the

Ordnance Select Committee and of the department of the Director of Artillery. Others, on the other hand, can hardly be said to be founded on more than inference, and inference in such matters, unless margins be allowed, is at times little better than guess work. I will endeavour to give an idea of the amount of dependence that may be placed on the table by taking up the case of one or two of the unsatisfactory lines.

"Devastation," "Glatton," and "Thunderer" Trace.

I will commence with Class A, which is given as a double line, A_1 running through the figure 180, and A_2 through 140. The latter represents the armour given on the table as that originally designed for the "Devastation," "Glatton," and "Thunderer," and carried out to a great extent, I believe, in the two former vessels.

In certain Swedish experiments in 1869, a target with front plates of a thickness of 12 inches, but with weaker back support, and constructed on a weaker principle than the kind in question, was completely penetrated with a "piercing figure" of 100·1. In July, 1871, a target at Shoeburyness (No. 33), consisting of 13 inches of iron, 12 inches of teak, and 1½ inches of skin, was completely and apparently easily penetrated by a "piercing figure" of 152·7. The only smaller registered blow on this target was one of 103·9, which of course failed to pierce, but which penetrated to a greater depth than might have been expected. The iron and wood were arranged in the following order:—8-inch plate, 6 inches teak, 5-inch plate, 6 inches teak, 1½ inches skin. The shot referred to penetrated to a depth of 18·2 inches; it therefore had in front of it ·8 inches of plate, 6 inches teak, and 1½ inches of skin. Now the "Warrior" backing, consisting of 18 inches of teak, and ⅝ths inches of skin, requires a force of 33 to pierce it; suppose we allow 36 for the work left undone by the shot in question, we should arrive at a "penetrating figure" of 139·9 for No. 33 target. Had the same shot penetrated through the same amount of iron and teak in our "Glatton" or thinner "Devastation" plate, viz., 12 inches of plate and 6 inches of teak, it would only have in front of it 12 inches of teak and 1½ inches of skin. We must not forget, however, that a projectile whose apex only is ·2 inches clear through the iron, and whose head is still held fast in it, must not be treated as if only backing and skin were left for it to pierce. On this species of reasoning 140 would seem a fair guess at the penetrating force. Again, the Plymouth breakwater shield with 15-inch plates, was completely pierced in August, 1870, by a blow of 114·4. The complicated structure, the Russian "Hercules" ought to represent as great resistance as class A_2, and she has been also brought to an estimate of 140. None of these experiments are such as we would desire for our purpose. No. 33 is the best representative target, although considered by some to be bad of its kind. Pending further experiments, we can hardly better our estimate of 140 as given on the diagram.

For the thick armour recently ordered for the "Thunderer," we have with a figure of 185·5, the point of a shell just showing through No. 35 target fired at at Shoeburyness in May, 1871. This No. 35

target consisted of 14 inches of plates, 15 inches of backing, and $1\frac{1}{4}$ inches of skin. On this, with the result on No. 33 target given above, I have based the 180 line. This line, while perhaps the most important in the diagram, is one of the most difficult to determine. Looking at the firing at No. 35 target alone, the figure might be taken at 186; but this single experiment hardly justifies the subsequent firing at No. 33 target being totally ignored, although no doubt it is less valuable than the proper representative test.

No. 33 has an inch less iron and 3 inches less teak, while it has $\frac{1}{4}$ inch more skin. We have already estimated it at under 139·9. Reckoning the $\frac{1}{4}$-inch skin as equal to 2 inches teak, No. 33 remains inferior to No. 35 by 1 inch of iron and 1 inch of teak, even allowing as much as 30 for this, the figure only rises to 169·9.

This mode of estimation is very unsatisfactory, and it has been said that No. 33 target did not actually represent anything, and, above all, that it contained a brittle plate. To this may be replied, that if the target was to teach nothing, why, in the face of the results obtained at No. 35 in May, 1871, was No. 33 fired at in July, 1871? When once this firing had taken place we have no right to ignore it without sound reason. The badness of the plate was only discovered when it was fired at, and it may be fairly argued that there are many such plates in the sides of our vessels, or at all events plates with the same fault in a less degree. For this is not a fault that either exists in its full extent or not at all. Plates may be brittle in a greater or less measure, and one very brittle plate may be held to indicate the probable existence of several exhibiting the same fault in a less degree; hence it seems sound to attach some weight to the firing at 33 target, enough at all events to bring the figure down to 180. However, in a few weeks' time, when the 35-ton gun is fired at Shoeburyness, better data may be obtained.*

To take another difficult case, that of the "Lord Warden" and "Lord Clyde," class E. A "Lord Warden" target in 1865 was nearly penetrated by a piercing figure of 88·4, while 92·0 penetrated it well. Probably about 90, as estimated by Captain Noble, was the force *just capable* of piercing this target. This firing, however, took place with spherical and cylindrical steel shot; an ogival-headed Palliser projectile would perform much better work. Thus a "Warrior" target in 1865 required a force of 61 to penetrate it, while with the present service Palliser projectiles, 53 is amply sufficient. A reduction of penetrating force in the same proportion for the "Lord Warden" will give the figure 78·2 nearly.

Starting again, to find our figure on another principle:—the 4·5″

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* Since the reading of this paper, the following results have been obtained:—

At Shoeburyness, on June 20th, No. 33 target, with an additional 4-inch plate (making 17 inches of iron, 12 of wood, and $1\frac{1}{2}$ skin), was pierced by the 35-ton gun, at 70 yards. In the above, this target (No. 33) is estimated as 139·9. Adding 20 for each inch in the extra plate, 219·9 is obtained as the piercing figure. On this occasion 219, or perhaps less, pierced it well.

At Portland, on July 5th, the "Glatton," turret thick portion (14 inches of iron, 15-inch backing, $1\frac{1}{2}$-inch skin), was nearly pierced by the 25-ton gun at 200 yards, the blow being about 181. These results accord more closely with the table than could have been expected.

plate, which forms the armour proper of the "Lord Warden," requires about 27·1 foot tons to pierce it. The additional support of the backing and skin may be set down at about 55; this would give an aggregate amount of 82·1. Thus, on the whole, if we estimate the piercing figure of the "Lord Warden" as about 80, we are not likely to be far from the mark, although the result is arrived at by a method adopted only in default of more definite data. I shall be happy to give the data as far as I have recorded them, on which I have traced in any line in the table. Even a thoroughly established figure, like that of the "Warrior," is liable to a certain amount of variation. Thus of three "Warrior" targets fired at about the same time, viz., Nos. 28, 25, 22, the first mentioned required nearly 54 to pierce it well, while 51 or 52 appeared to be sufficient for the others. Whether this result be due, as suggested by the Committee, to different degrees of soundness in the backing, or to accident, one of two things must follow: either the same vessel may be penetrated by a rather less blow as she grows older, or else different portions of her side vary sensibly in their powers of resistance. The object of the table, however, is, as I have said, not so much to lay down absolute rules, as to recommend a simple plan on which Officers might deal systematically with the vessels they might encounter, a plan which would admit of being worked out more thoroughly as time goes on, and on which any new line might be at any moment drawn in by anybody who happened to learn the penetrating figure of any ship.

Foreign Armour-Clads.

The figuring and lines printed in red on the diagram refer to armour-clads of foreign Powers, of which I believe those in the table (see Appendix) are on the whole good representatives. It is difficult to estimate the "piercing figures" of the French and American vessels fairly. We have, however, also given some general facts concerning their armour and backing. The French vessels having, as a rule, *no skin*, would be liable to injure their crews to unusual extent by splintering. The laminated armour possessed by most American ships is very inferior to solid plates of the same thickness. The results obtained at Shoeburyness seemed to indicate that a solid plate of 4 inches thickness was very superior to 6 inches made up of $\frac{5}{8}$-inch plates. Sufficient experiments, however, have not been carried out to establish a trustworthy comparison between solid and laminated armour, and on this account, as well as the peculiar application of armour-stringers, it is difficult to estimate the figures for American ships. Another feature in American vessels is the rapid diminution of the armour below the water-line. Mr. Reed points out, in the work above quoted, that at 3 feet below the water-line the "Dictator" has only a single inch-thickness of armour, and the "Kalamazoo," at 2 feet 9 inches, has 3 inches only. Clearly it would be well to aim at American vessels below the water-line. Lastly, we may notice that the armour in American turrets is not thickened in the manner pursued by ourselves. As to the other foreigners, the Russian "Hercules" is a gigantic design both as to guns and armour, and ought to be a most formidable ship whenever she is afloat. The Austrian ships afloat are weak generally in armour at present. This would be remarkable, for the very name of the "Lissa" reminds us that Austrian armour-clads have really fought, and any preference shown by Austria for light armour would deserve special notice; but Count Dubsky, in answer to my inquiries at the Austrian Embassy, has kindly informed me that they have two really heavily-clad vessels now in construction. I do not know exactly what backing these vessels have to their armour, but I conclude we may place them somewhere between the "Cyclops" and "Hercules" classes.

The Danish Minister has kindly obtained the information given with reference to the Danish Navy. It may be seen they have some vessels with a high class of armour, ranking about classes C and D.

In speaking of the diagram giving information in a form easily grasped, it may be well to make what may be called an incidental use of it, for example:—

We want to determine the best gun for a certain fort. We see that if we employ the 12-ton gun we can only keep vessels of the "Cyclops" class at a distance of a little over 400 yards, but if we like to go as far as 18 tons, this class must fall back to a range of over 2,000 yards. So, again, if we want to defend a space of 3,000 yards against the Russian "Hercules," we see that for this we must employ a 35-ton gun.

Again, let us compare the respective performances of the guns by means of the "Hercules" trace. This vessel is too much for the 9-inch gun even at the muzzle, but the 10-inch drives her back to nearly 1,200 yards. The 12-inch of 25 tons is generally beaten by the 11-inch gun, but at the short ranges it has an advantage. The bend and slight advance forward which the lines A_2, B, and C make when passing from the 11-inch gun and coming opposite to the 12-inch, is a feature that must not be overlooked, but it is easily explained. The weights of the 11- and 12-inch guns are identical, so are their firing charges, therefore it is not surprising that the projectile of the latter, although weighing only 535 lbs., should keep up its velocity better than the 600-lb. shell of the former, the surfaces of resistance being nearly in the proportions of 10 to 12, while the weights are in the proportion 10·7 to 12. The circumstance that the 11-inch gun is of later introduction, and in fact rather supersedes the 12-inch, would account for some improvement in proportions. At the same time, there is no use in shutting our eyes to the fact that the difference with common shrapnel shells would have been very much more marked. The 12-inch gun supplies one of those instances where the evil of running the risk of making mistakes was preferred to the evil of submitting a question to the mathematical referee of the Committee, the result being the introduction of a gun with a twist which was insufficient to keep its proper 600-lb. common and shrapnel shell point first; so that there exists a mixture of 495 and 600 lb. projectiles with corresponding differences in ranges or elevations. This arrangement, and their remarkable case shot, we may look upon as the Woolwich guns' contribution to the "queer things of the Service." But to return to our subject.

As time goes on, it appears possible that the lines may be found to approach a little too close to the guns, because the projectiles gradually improve; and although we may not adopt the suggestion of the Committee that the ships deteriorate to a sensible degree, yet they cannot be expected to improve by keeping. On the other hand, the estimate in the table, which is based on the supposition of the best projectiles yet made being fired, may be found too high for some of those still existing in our equipments and those of foreign nations.

Perhaps I have sufficiently explained the table, I will pass on to its use on service.

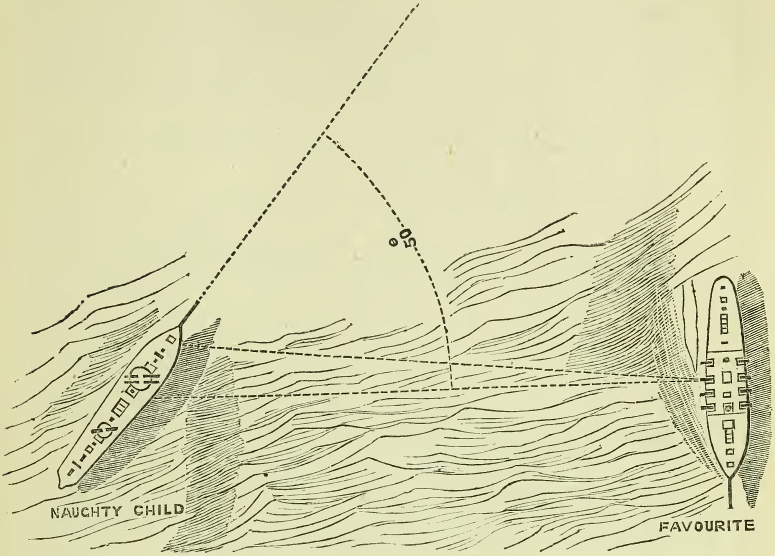
I will suppose a case. I am in a small iron-protected fort, witnessing the approach of a short, handy-looking vessel with a spur bow. I cannot expect to be able to say exactly what she is and what armour she carries, but there is enough about her to make me guess her as falling somewhere between the classes B and E.

My armament I will suppose to consist of one 10-inch and two 7-inch guns. It is hardly possible, I say to myself, she can be a vessel of such strength as our English "Hercules;" in fact, I think, looking at my table, I ought at all events to stand a good change of piercing her at a mile range with my 10-inch gun. Possibly I cannot pierce her at any distance with my 7-inch guns. I will assume that she must approach within a mile range to effect any good purpose. I decide, then, to reserve my 10-inch gun, and in the mean time to feel her sides, and learn all I can, with my two 7-inch pieces. First, is she an armour-clad at all, or only passing herself off as such, and approaching a certain distance for some investigating purpose? To ascertain this I fire Palliser shells at her. Should I observe a distinct burst against her side I know she must be armour-clad, as these shells, having no fuzes, cannot act on impact against wood or thin iron. If, after repeated hits, no burst occurs, we conclude she is wooden and change to common shells, and open at once with the 10-inch gun in addition to the others. Should she on the other hand prove to be armour-clad, we continue with the two 7-inch guns only, not so much with the hope of piercing her as of effecting smaller injuries, getting her range, finding out her present rate of speed exactly, and taking her return fire. At a mile range the 10-inch gun, well and deliberately laid, opens on her, when it would depend on what she is and what is her object, whether she could push her course further, or what would become of her.

It may be objected that by only firing my 7-inch guns I may lose the opportunity of piercing the armour of a ship which may draw off before coming within a mile. On the other hand, is it not possible that before attempting a passage up a channel with various classes of ships, some very heavily clad vessel might be ordered to stand in and feel the fire of the fort? Knowing the range at which she was struck, and observing the indentations in her armour, it would become easy to lay down how near each ship in the fleet might approach the fort, supposing the latter put forth her full power against any vessel that approached.

Again we come to the question of where to aim?

I believe I am right in considering that the opportunity of hitting a vessel between wind and water when engaging her from the windward side is now no longer offered, because vessels would not fight under canvas, and instead of heeling over would only be subject to a little rolling, and that probably not sufficient to give any real opening for a blow either below the water line or over one side into the deck, or backing and interior of the other side, at least so I understand from the naval Officers whom I have questioned on the matter. In the case of a battery in an elevated position, however, it would probably be right to watch for an opportunity of firing shell so as to strike the deck or interior of the backing beyond. The bursting a shell so fired might be expected to be very destructive, because the armour would drive the explosion into the interior of the ship. Common shell, however, would have to be resorted to, for it is a question whether Palliser shells, fired as they are without fuzes, would explode under these circumstances. The late Lieutenant Boxer, R.N., advocated the employment of percussion fuzes in the plugs of Palliser shells, and some experiments were carried out at Shoeburyness relative to his proposal, but, after achieving some success, he was discouraged from continuing his efforts in this direction. As it appears as if it were specially difficult to injure a well-constructed vessel along her water-line, in her engines, or in her rudder or propeller, under ordinary circumstances, it is hard to say at what part of a vessel we ought to point our guns. Some time since I asked an American naval Officer where his experience would lead him to advise me to aim. To which he replied, "You must hit her where you can." Now, although it may be admitted that the difficulty of selecting a spot at which to fire may be great, indiscriminate firing can hardly be advocated under any circumstances. Indeed, were there no other recommendation, systematic firing would be more likely to lead to learning something definite than mere chance shooting, and is, therefore, to be preferred. In certain cases, however, there seems room for decided preference as to where to aim. Take the case of class A, that of the "Devastation" and "Thunderer." It has recently been decided to strengthen the turrets and the armour in their vicinity very considerably, consequently it would be desirable to strike the side of the vessel rather than the turret, and what is true of these ships is, in a less degree, true of most turret vessels. The side is almost entirely below water, but now that the power of projectiles has enormously increased, while water, of course, remains unaltered, it is much more feasible to deliver a blow well below the water-line than formerly. With turret ships, then, it seems probable that the best plan to pursue would be to aim at the water below midships or elsewhere. In the "Hercules" and other vessels, to say nothing of the "Warrior," I believe the armour is thinner at the quarter than midships, a fact which would deserve consideration. Then again the port-holes are to be considered. Now that they are made so small, no doubt it would be very difficult to send a shell through them, but I presume this should be the aim of a gun which is known to be powerless to pierce the armour. Lastly, failing a more definite object, it would surely be well to fire at that portion of the ship where the armour is presented so as to receive the most direct blow. To explain: in Fig. 2 are roughly given the plans of two vessels taken from Mr. Fairbairn's work on iron ship building; the "Favourite," and Captain Coles' hypothetical vessel the "Naughty Child." It may be seen that the latter ship is shown firing her guns at an angle of 50° with her keel, while the former is shooting right abeam. Under these circumstances the projectiles of the "Favourite" striking the greater part of the "Naughty Child's" side, would have their power of penetration very greatly reduced; in fact it is doubtful whether shell would not glance off, and shot would undoubtedly do so. It would be a digression here to discuss the question of the impact of shot on armour at an angle. It is probably well known and accepted by most of those present, that at a very oblique angle the projectile glances off point first. At one rather less oblique, it is apt, even after the point catches, to turn too rapidly, and to have too little penetrating power to become *encastrè*, so that it wheels off base first, but rapidly turning end for end. In either case the projectile must carry away a large portion of the work stored up in it, so that the blow on the armour must have been comparatively slight (*vide* Mr. Mallet's papers in the *Engineer*). We may say confidently, however, that there is no chance of a projectile penetrating even sufficiently to turn it in its flight and throw it off, whirling in the manner above noticed, if it impinges on armour at an angle much more oblique than the tangent to the curve of its head at the apex. It is true that a considerable amount of injury has been done to thin plates of iron (an inch or half an inch thick) by projectiles striking at an angle as oblique as 8° (*vide* the experiments conducted against deck plates at Shoeburyness on May 3rd and 5th,



1871), but the projectiles glanced off, the shells in fact not receiving a sufficient blow to explode these charges: so that although a certain amount of rending occurred, nothing that could be called penetration, nothing that could produce much effect on real armour-plates took place. The experiments that have been carried out with a view to penetration into iron when striking at an angle, seem to support Mr. Mallet's statement. Tangents to the curve of the service ogival-headed projectiles at the apex would form the following angles with the axis in each case. With a head struck with a radius of $1\frac{1}{4}$ diameters, 53°, 8′, and with that of $1\frac{1}{2}$ diameters, 48°, 12′. The latter form is that now given to all Palliser shell, and in the case of the larger calibres to Palliser shot also. It becomes a question then, whether even the shell would bite and become *encastrè*, and at all events, a turn of a few more degrees would settle the doubt. Under such circumstances, the "Favourite's" only chance of obtaining penetration would be to strike the "Naughty Child" between bow and quarter, at the point where the dotted line in the figure forms a normal to the curve. It would be interesting to proceed further, to speculate upon the wisdom of a ship always engaging an adversary so as to fire at an angle to her keel, and so to present her armour at an inclined position. In smooth water this would, I should think, be more successfully carried out than when there was any sea on, because in the latter case the rolling of the ship would alter not only the elevation of the guns, but their line also; and it might thus be more difficult to make good shooting. Then again comes the question whether a ship could manœuvre so as to draw a damaged part of her armour out of the fire of her adversary, a consideration which might be more important if she was subject to a racking fire than a punching one, because in the latter case the damage is confined to a small spot which is hardly likely to be struck a second time. Lastly, it may be asked, how far may the crew of a ship be injured by the flying off of bolts and nuts from the impact of shot whose power is not sufficient to give actual penetration? However, I have gone far enough to indicate the direction in which I believe information is much required, such information perhaps as many naval Officer could, in a great measure, supply, but such as I do not think is to be found in any work that is accessible to Officers generally.

APPENDIX.

List of British Armour-clad Vessels, with thickness of Armour Backing and Skin, taken principally from Mr. Reed's "Iron-clad Ships," but Classified according to the blow per inch of Shot's circumference estimated as sufficient to pierce each description of Armour.

Name of vessel.	Thickness of armour in inches.	Thickness of backing in inches.	Thickness of skin in inches.
Class A, 180 and 140:			
Thunderer (T.*) thick portions	14 12	15 18	1¼ 1½
Devastation (T.)			
Glatton (T.)			
Fury (T.)	?	7	?
Class B, 130:			
Hercules	9 to 6	12 to 10	1½
Sultan	9 to 6	12 to 10	1½
Hotspur	11 to 8	12	1¼
Rupert	12 to 11	12	1¼
(The water-line backing much thicker.)			
Class C, 110:			
Cyclops (T.)	8	10	1½
Gorgon (T.)			
Hecate (T.)			
Hydra (T.)			
Class D, 85:			
Monarch (T.)	7	12	1½
(The Captain belonged to this class.)			
Class E, 30 (wood built):			
Lord Warden	4½	31½	1½
Lord Clyde			
Class F, 70:			
Bellerophon	6	10	1½
Penelope	6	10	¾
Invincible	6	10	1¼
Audacious			
Vanguard			
Iron Duke			
Swiftsure			
Triumph			
Class G, 53:			
Warrior	4½	18	⅝
Black Prince			
Achilles			
Defence			
Resistance			
Hector			
Valiant			
Prince Albert (T.)			

* (T.) indicates a turret-ship.

List of British Armour-clad Vessels (*continued*).

Name of vessel.	Thickness of armour in inches.	Thickness of backing in inches.	Thickness of skin in inches.
Class H, 52:			
Minotaur	5½	9	⅝
Agincourt			
Northumberland			
Class I, 50† (wood built):			
Royal Sovereign (T.*)	5½	36	nil.
Royal Alfred	6	29½	nil.
Repulse	6	31	nil.
Class K, 40† (wood built):			
Caledonia	4½	29½	nil.
Prince Consort			
Ocean			
Royal Oak			
Research	4½	19½	nil.
Enterprise			
Pallas	4½	22	nil.
Favourite	4½	26	nil.
Zealous	4½	30½	nil.
(Iron built.)			
Viper	4½	10	½
Vixen			
Waterwitch			
Scorpion (T.)	4½	9	½
Wyvern (T.)			

List of certain Foreign Armour-clad Ships.

French Ships.

Name of vessel.	Thickness of armour in inches.	Backing, &c.	Piercing figure.
Bélier	$8\frac{2}{10}$	For the most part thick backing and no skin.	110 and 85.
Marengo	$7\frac{8}{10}$		85 and 70.
Flandre ?	6		55 and 50.
Taureau	6		55 and 50.
Alma	$5\frac{8}{10}$		55 and 50.
Couronne	4½		53.
Palestro	4½		53.
Gloire	4½		40.
Magenta	4½		40.
Solferino	4½		40.

(Two heavily-clad French ships building.)

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* (T.) indicates a turret-ship.

† In these, water can enter when 8 in. or 10 in. of the wood is penetrated.

American Ships.

Kalamazoo	6 (in 3 in. layers)	30 in. and 3 stringers, each 8 in. by 8 in.	130.
Dictator Pusitan	6 (in 1 in. plates)	42 in. and 3 stringers, each 5 in. by 5 in.	100.
Canonicus Miantonomoh Monadnock	5 (in 1 in. plates)	27 in. and 2 stringers, 6½ in. by 4 in.	50 to 40.
Passaic Monitor	Ditto	39 in. and 27 in.	50 to 40.

Danish Ships.

No. 56 (building).	8 in. plates	10 in.	110 (about).
Gorm	7 in. plates	10 in.	85.
Denmark	5 in. plates	18 in.	70.
Danebrog* Pider Skram*	4½ in. plates	28 in.	40 if wood built without skin.
Lindormen	5½ and 5 in. plates.	10 in.	Under 55, and downwards, according to skin, &c.
Rolf Krake	4½ in. plates	10 in.	

Russian Ship.—The Russian Hercules (The Peter the Great), 140.

Prussian Ships.—Konig Wilhelm, 91; Kron Prinz, 62; Friedrich Karl, 62; Arminius, 40.

Austrian Ships.—Kaiser, 51; Lissa, 51. Building: The Custozza and Archduke Albrecht; perhaps about 120 to 80.

Italian Ships.—Principe Amadeo, 74 and 62; Venezia, 43.

Greek Ship.—King George, 69.

Turkish Ship.—Avni Illa, 69.

Commander W. Dawson, R.N.: My Lord, Captain Orde Browne need not apologise for treating on naval artillery science before a naval audience, for I know not where the Navy would be in gunnery matters if it were not for the researches and studies of Officers of the Royal Artillery, on whom we are so much dependent for gunnery ideas, as when General Sir Howard Douglas first taught us the elements of artillery science. I have read with much profit the able papers from the pen of Captain Orde Browne in the "Engineer," and am not disappointed in my expectation of hearing to-night a very instructive and very useful paper. The larger table places before us, in a most convenient form, condensed information of a most valuable and important nature, and it will, no doubt, be exceedingly useful to students and instructors for reference, as to the relative values of guns of different calibres, and of the least vulnerable parts of various ships. But there is a wide interval between the relative and the absolute values of objects. And, if we take this table from the student's desk into the battery, and attempt to utilize it for practical artillery fire, it will be found exceedingly misleading, and, therefore, worse than useless. The absolute value of a gun must be the work which it will actually accomplish in battle. The absolute value of a ship is the measure of its indestructibility in action. Now this table of relative values throws very little light on these two practical points, but, on the contrary, egregiously misleads the operative gunner. First, as to the gun, the perforating ranges are worked out on the assumption that the shot will strike at right angles to the ship's side. This never can occur at sea except by a rare accident. The trajectory of the shot forms an angle, the curvature of the ship's side forms a second angle, the roll of the ship forms a third angle, and the inclination of the ship's course towards or from the trajectory forms a fourth angle. Now, the penetration at angles is the most vital point in nautical artillery science, and on this the great table throws no light. The form of front, moreover, which will perforate at the largest angles is disputable. Mr. Mallet proves mathematically that pointed shot bite at the largest angles from the perpendiculars, and the Government have accordingly adopted ogival heads. But I have seen and handled in Sir Joseph Whitworth's office in Pall Mall iron shot and iron plates, by which the angle at which perforation ceases to take place with flat fronted and with sharp pointed shot, has been practically tested. Whitworth shows an iron plate perforated at an angle of 65° from the perpendicular by a flat-headed projectile, six diameters long. He also shows the relative penetrations of projectiles 3½ diameters long, in which the hole is fairly punched at 45° by the flat-headed shell, whilst the ogival-pointed shot of similar dimensions has failed to perforate at the same angle. We have thus certain hard facts on one side, and I should feel obliged to Captain Orde Browne if he could refer me to the hard facts, the experimental data, conducted by the Government which support the conclusion arrived at on their side, that pointed shot perforate at the largest angles.

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* Altered to iron-clads.

Again, perforation is seriously affected by the more or less complete consumption of the charge. Everybody knows that when a gun is repeatedly fired on the same day it becomes heated, and recoils more violently. That increased recoil tells of powder being consumed which was before thrown out of the gun unconsumed. Now, an increased consumption of powder is virtually an enlarged charge, and the increased recoil indicates an increase also of the velocity of the shot, *i.e.*, supposing that the shot is free to escape, and does not wriggle and become obstructed in the bore by vicious rifling. So well is this increased effect on the gun understood, that not one of our heavier guns have been subjected to repeated discharges on the same day. Our 18-ton, 25-ton, and 35-ton guns have never been so tested, lest they should be destroyed by their own wriggling projectiles during their more violent ejection from the bore. But this increase of recoil in the gun, and increase of velocity in the shot, implies increase of penetration as the gun warms. This will suffice to vitiate those refinements of mathematical calculations alluded to in the formation of this table.

Again, it is well known that the endurance of guns is seriously affected by frosty weather, giving brittleness to the material of which they are constructed. Might not the influence of differences of temperature upon armour plating affect also the perforation?

2nd. As to the ships. The strength of any structure is measured by its weakest not by its strongest portion. To tabulate the strongest portion of iron-clad ships, in the form given in the large table is, therefore, most misleading. And I would venture to add that it is a mistake to insert English ships in such a table at all. The British artillerists do not want to punch British ships, but foreign vessels. Let, then, foreign ships be substituted throughout for British vessels, if the table is to be practically useful. But what the British artillerist wants to know is not so much the thickness of the plating on foreign ships, as how it is distributed?—where are the vulnerable parts. Half-a-dozen diagrams hung in every ship's battery, and in every coast battery, would show near enough for the practical purposes of war where the armour is borne in half-a-dozen classes of foreign ships. And if the masts were also shown in the diagrams even a soldier might determine to which class the approaching ship belonged, and where, with reference to the masts, he ought to aim so as to hit the "soft" places. Such diagrams would be most invaluable to artillerists, and such information would be ten times more valuable than one-half of what is taught on board the "Excellent" at this moment. For he would thus learn that it mattered not what gun he had in charge, but that even the projectiles from field guns could sink certain ironclads, if they struck certain portions, and could set fire to others if they struck other portions. They would also learn that the maximum thickness of armour given in Captain Orde Browne's table does not extend over all of even the protected portions, but is limited to a very small area. The gunner would thus learn what strong portion should be avoided if the ship presented herself at a bad penetrating angle; if the object was too distant for perforation, or if the gun was unequal to such heavy work. Possessed of such information no gunner need despair, whatever his weapon, of injuring, if not destroying, a partially clad adversary.

Again, the armour belts round the water-line are getting narrower and narrower, with every increase of thickness. In this respect the destructibility of a ship is, therefore, increased in proportion to what Captain Orde Browne estimates to be her invulnerability. For example, some ships carry their armour belts but four feet below and two feet above their water-lines. Now, in fine weather, with the ordinary ocean swell, the fore part of the ship commonly rises out of water at each pitch and roll more than double four feet, and "sends" below the water more than double two feet. Let the artillerymen plant a small shot immediately above or below the armour belt, near the bow, and the boasted invulnerability comes to nothing, or, rather, helps to carry the ship to the bottom.

Again, should foreigners copy our "Devastation" turret ships, the exact study of the position of the armour plating will become still more essential to the artillerist. Such a ship coming near the forts on Staddon Heights or Maker Heights, at Plymouth, would be easily destroyed by plunging fire, if our artillerymen know anything about armour, and should she be encountered by a badly armed British ship, our seamen gunners ought to know the utter waste of strength involved in hitting at certain parts, and the ease with which intelligence and skill could plant projectiles from the smaller guns into the vulnerable portions. For example, a small shell grazing the top of the turret on the lower or lee side, would enter the turret, destroy the gun-carriages, and render the vessel, as to artillery, helpless. If, thus disarmed, the turret ship attempted to ram and failed, the British seamen who failed to sink her with a plunging fire skilfully directed would pass down in history as examples of imperfect gunnery training.

Invaluable, then, as Captain Orde Browne's table is to students in deciding the relative values of various guns, and of the least vulnerable portions of various armoured ships, it would be most misleading to the practical artillerist who relied upon it in directing the fire of guns, whether we consider the absolute powers of their projectiles or the destructibility of the ironclad ships referred to.

Lord Lauderdale: I think we are much indebted to Captain Browne for the interesting and instructive paper he has read, and in which he has set forth in a tabulated form the penetration of armour plates by the various guns now in use in the service, by shot fired at right angles direct, and although the diagram does not give the penetration at various angles, still it will be a very useful table; there is no doubt that it is a most important point to ascertain the effect of shot fired at considerable angles, as in naval actions ships will endeavour as much as possible to avoid exposing their direct broadside to the enemy.

The subject of penetration of armour plates has generally been discussed as simply a matter between the guns and plates, but this appears to me to be a mistake; the gun is certainly the main instrument, but much depends upon the form and temper of the shot, and the nature of the powder used. I believe I was one of the first to carry out the experiments at Portsmouth against iron plates; we began by firing common round shot, and found they always broke up and would not penetrate the 4-inch plates. Wrought-iron shot were then tried, but they would not penetrate, but flattened against the plates. Elongated pointed shot were then fired from the rifled guns, but they also failed to penetrate the 6-inch plates, the points generally giving way, and it was not until Major Palliser came to our assistance with his *hard-pointed* chilled shot that we succeeded, but even then shot when fired from the 18- and 25-ton guns seldom penetrated the 12- and 15-inch plates, owing, in my opinion, to the shot always breaking up, for after penetrating 9 or 11 inches the points were found sticking in the plate quite uninjured, but the other part of the shot was reduced to powder; my belief is that those shot would have gone through the plates if they had not broken up. I have lately been informed that the shot are now so cast that only the points are chilled, and the rear is so tempered that they do not break up. Again, much depends upon the nature of the powder used for the large rifled guns; the common L.G. will not give the velocity that pebble powder will give.

With regard to the penetration of shot when fired at various angles against iron plates, it is yet a disputed point whether *flat*-headed or pointed shot are the most efficient. Many advocate the flat-headed shot, amongst others Sir J. Whitworth, and I believe the French and most foreign nations use the flat-headed shot, but they also have pointed shot for *direct* fire; there is no doubt that the flat-headed are the most efficient when fired through water, the only objection that I know is that when fired under ordinary circumstances, they are not so true at long ranges as the pointed shot.

Captain ORDE BROWNE: I think Captain Dawson's first observation referred to the plan of the diagram. Captain Dawson observes that a vessel's armour would never be struck *exactly* at right angles, and frequently at an angle of incidence so oblique that the calculations shown on the table could not hold good. This objection is valid, nevertheless I would point out that the relation between the force to punch a plate direct, and that required to do so at an angle, appears to be a simple one.* Any attempt to show the force required by each class of armour at many angles would enormously complicate the diagram. It appears to me preferable to have it in its simple form, which gives a good basis to which any rule of thumb may be applied, according to judgment.†

Captain Dawson next raised the question of the relative powers of flat-headed and ogival-headed projectiles striking armour at an angle. It would be easy to discuss this question theoretically at great length. As, however, it hardly comes within the range of the subjects touched on by the paper, it would be better not to do so. Captain Dawson, however, asks for the results of the experiments on which ogival-headed shot have been preferred for angle firing. It is difficult to give these, because although a great deal of firing at angles has taken place with each kind by itself, I believe no actual public competitive trial has ever been made. The paper of Sir J. Whitworth, quoted by Captain Dawson, is an account of a private trial made by him of his own projectiles, so that it would not be fair to put it on the ground of an experiment conducted at Shoeburyness.‡ I believe I am correct in saying that Major Palliser long since invited Sir J. Whitworth to a public competitive trial of the powers of their respective projectiles when fired at armour at angles.

In the last competitive direct firing, Sir J. Whitworth employed a projectile with an ogival head, as well as a flat-headed one. I believe the *ogival* one obtained the greatest penetration he has ever achieved. As concerns the diagram, the supposition that the penetrating powers of shot vary as the number of foot tons per inch circumference, would be more truly correct in the case of a flat-headed projectile than an ogival one, for a flat-headed bolt must be supposed to act very much like a punch, and to cause the plate to give way by cutting a disc out of it, in doing which the shot has actually to shear the plate along the line in contact with the circumference of its head; the action of an ogival head is different (*vide* a paper written by Lieutenant English, R.E.), and the law assumed less correct.

Captain Dawson's suggestion of a diagram showing the weak parts of foreign armour-clads is a valuable one, and might well be carried out; some difficulty may be anticipated in obtaining all the information concerning vessels like the French and American, which are built abroad, but such a table is exactly the kind of thing that I believe is needed for the service.§

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* It has been said that the penetrating force required varies inversely with the size of the angle of incidence. Sometimes this nearly agrees with the results of experiment; for example, in December, 1866 a "Warrior" target at 60° required 65·0 foot tons to pierce it—65 × S in 60 = 56, which is very nearly the force required at that time to pierce the "Warrior" direct.

† A vessel may generally be struck at one point at a normal to her side if desired, as instanced in the supposed case of the "Favourite" and "Naughty Child."

‡ On Oct. 8th (since the reading of this paper), Sir J. Whitworth tried his new 9-pounder breech-loader publicly at Southport, with which gun he drove a flat-headed projectile through a 3 inch plate, at an angle of 45°.

§ The objection against furnishing the lines of our own ships on the diagram belonging to this paper, is met by the reflection that it is as important that our vessels should know where they are *liable to be pierced* as where they can pierce others. Again, to make sure of piercing a ship's side, we must know her maximum thickness, a weak place must at best be an uncertainty.

LECTURE.

Friday, 14th June, 1872.

Vice-Admiral OMMANNEY, C.B., F.R.S., in the Chair.

PRACTICAL NAUTICAL SURVEYING.

By Staff-Commander Thomas A. Hull, R.N.,

Hydrographical Department, Admiralty.

The object of this paper is to enable an Officer possessing the ordinary knowledge of his duties as a sailor and navigator, aided by the usual instruments found on board every man-of-war, to construct a plan of a bay or harbour, detect errors in the chart of a piece of coast line, or frame a report on a newly discovered island, rock, or shoal. Such contributions to knowledge, although standing only in the relation of sketches when compared with finished surveys, still may, in the absence of better information, be of great assistance to his fellow seamen, and qualify him for employment in a branch of the service which has been second to none in placing and maintaining the British Navy in its prominent position among the forces of civilization.

An Officer having passed his examinations for a Lieutenant may feel a desire to retain the knowledge he must have acquired in navigation, and may wish to gain some experience in nautical surveying. The first step to insure real success and self-reliance in the art, is to do what I am quite content to term *educating himself down to it*, by mastering such simplicities as every day arithmetic, since readiness in the first four rules, proportion, vulgar fractions, and decimals are of the greatest use to the practical nautical surveyor, and are in fact necessary to enable him to use logarithmic tables. Euclid's first four books, with a part of the sixth, algebra, as far as simple equations, are also required to enable him to use practical trigonometry. These studies may be lightened by practical geometry, as treated by Raper in pages 21 to 32 of his "Practice of Navigation," thereby gaining facility in handling those powerful instruments the scale and compasses. In working problems for practice in plane trigonometry, every triangle should be projected, and the problem solved by construction as well as calculation.

The ordinary problems of navigation thus handled elevate themselves into nautical surveying. Take for instance a common day's work, in which (see Diagram 1) a vessel contending with adverse winds has made six tacks, which, corrected for variation and deviation give the following true courses, viz.: W.S.W. 16 m, S.E. by E.$\frac{1}{2}$E. 10 m, W. by S. 11 m, S.E. 24 m, E.S.E. 10 m, and S.W. by W. 24 m. Draw the meridian line AD, and lay off from a known position at A an angle of 67° 30′, from south towards the west, A*a* is then drawn, and made equal to 16 m, the first distance. At *a*, from *a*A, an angle of 50° 37′ is laid off towards the east, equal to 4$\frac{1}{2}$ points, or the angle between E.N.E. and S.E. by E.$\frac{1}{2}$E., and *ab* made equal to 10 m; at *b* an angle of 39° 22′ is laid off equal to 3$\frac{1}{2}$ points, or the angle between N.W. by W.$\frac{1}{2}$W. and W. by S., and *bc* made equal to 11 m; similarly the other angles and distances are laid off till the point C is reached, and CD is drawn at right angles to AD.

Supposing, as is often the case, no current has been experienced, a triangulation has been thrown over the water, the triangles being right angled; or the courses and distances represent the true bearings and distances taken and calculated from time to time in an ordinary survey. Assisted by the traverse table the triangles are worked out, and the position of C found trigonometrically; this is checked by comparison with the position obtained at C, by astronomical observations. The departure can be turned into diff.-long., and the sheet graduated as in the actual survey of a coast. Thus navigators become surveyors in spite of themselves, and triangulate without knowing they are doing so.

Necessary Geometry.—When in sight of land a common method of fixing a ship or boat is by observing two objects that are in transit, *i.e.*, situated in the same line as the ship or boat, and taking an angle between them and some well known object to the right or left, taking care that the angle measured is not less than 25°. A line is then ruled through the objects in transit, any point is taken in it, and from this the angle observed is laid off in the direction of the third object; a line, ruled through that object, parallel to the line forming the angle, will intersect the line ruled through the objects in transit on the position of the ship.

Thus in Diagram 2, two points, D and L, whose positions are known, are observed to be in transit from a station P, and an angle LPS of 51° is measured between them and a third known point S; through D and L a line DL*p* is drawn, and at any point *p* in that line, an angle D*ps*, equal to 51°, is laid off towards S, and a line *ps* drawn; then through S a line SP is drawn parallel to *sp*, cutting DL*p* in P, the position required.

Diagrams Nos. 2, 3, and 4 illustrate certain questions in nautical surveying on which some time may be most profitably spent, as they represent the means whereby positions may be fixed, and are, therefore, of the greatest use to both navigator and surveyor, especially in the determination of positions afloat.

These questions are solved by means of the 20th, and the 21st, or 22nd propositions of the III, and the 5th of the IV books of Euclid.

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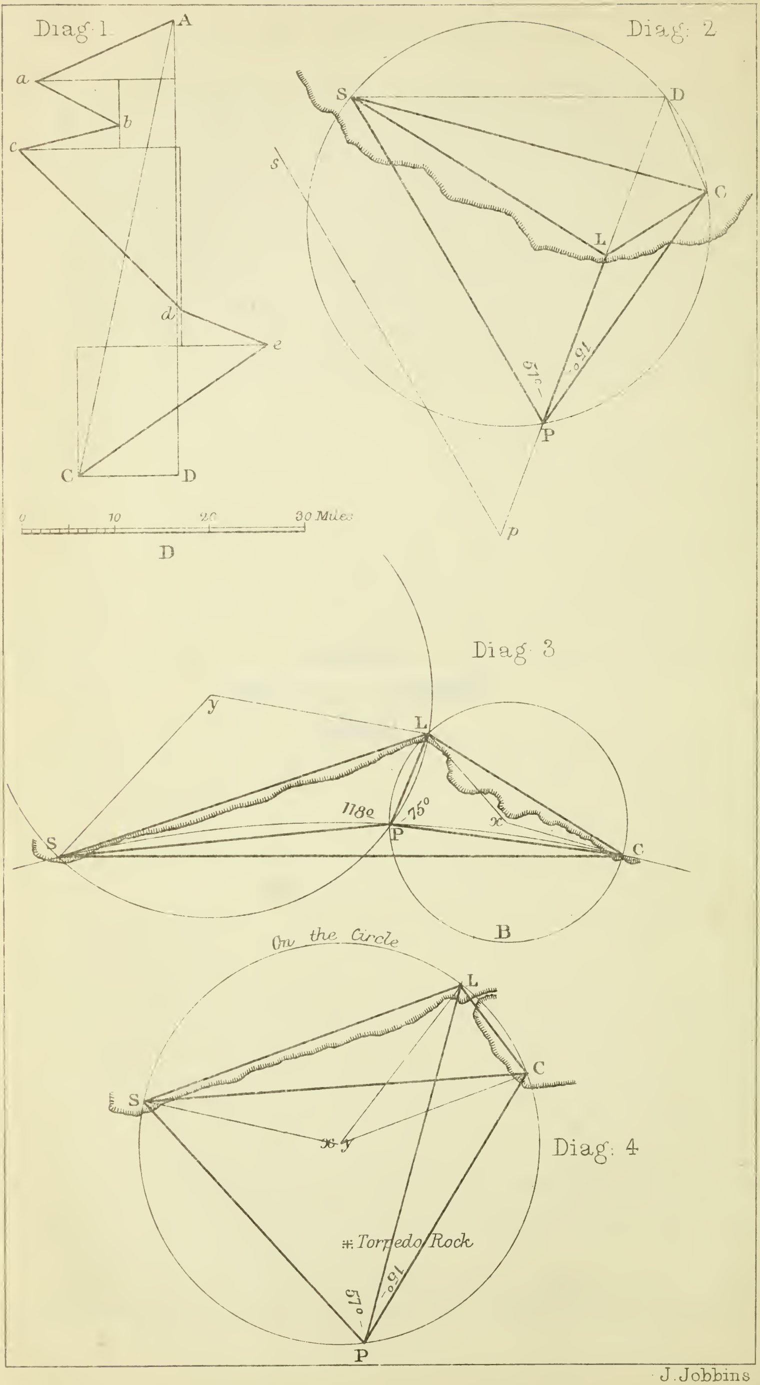
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J.Jobbins

The 20th proves that *the angle at the centre of a circle is double of the angle at the circumference upon the same base, that is, upon the same part of the circumference.*

The 21st proves that *the angles in the same segment of a circle are equal to one another.*

The 22nd proves that *the opposite angles of any quadrilateral figure inscribed in a circle are together equal to two right angles*, and

The 5th of the IV shows how *to describe a circle about a given triangle.*

Sailing along a coast three objects are observed—the tall chimney of a factory (C), a lighthouse (L), and the spire of a church (S), (see Diagram 2); the bearings and distances between these objects can be obtained from the chart. It is required to fix the position of the ship by angles measured from her between the points C and L, and also between L and S, the former being 15°, the latter 51°, the assistance of station pointer or tracing paper not being available.

Projecting by Circle and Line of Direction.—Join CS, and at C, on the opposite side of CS to that on which the ship is situated, make the angle SCD equal to 51°, or the angle subtended at the ship by the line SL. Similarly at S make the angle CSD equal to 15°, or the angle subtended at the ship by the line CL. The intersection of these lines gives a point D. About the triangle SDC describe the circle SDCP, and through L draw the line DLP, cutting the circle SDCP in P.

The point P will be the position required.

Join PC, PS; then DPC and DSC, being angles in the same segment, DSPC are equal; DSC was constructed equal to 15°, therefore CPL, the angle between the chimney and the lighthouse, must equal 15°. For similar reasons SPD and DCS, being angles in the same segment, DCPS are also equal, and LPS the angle between the lighthouse and the church spire, must equal 51°, and thus the position required has been found.

Projecting by Circles.—In the 3rd Diagram as one of the angles exceeds 90° another method must be followed. The angles measured in this case are 75° between C and L, and 118° between L and S.

From L and C on the same side of the line LC as that on which the ship lies, lay off the angles CLx and LCx, each equal to 15°, the complement of the angle subtended by CL; the intersection of these lines gives a point x, then with x as a centre and xL as radius describe the circle LPBC.

Subtract 90° from 118°, the angle subtended by SL, and from S and L, on the opposite side of the line SL to that on which the ship is situated lay off the angles LSy and SLy, each equal to the 28° thus obtained; the intersection of these lines gives a point y; then with y as a centre and yL as radius describe a circle LPSD, cutting the circle LPBC in P.

The point P will be the position required.

Join PC, PL, and PS, then because y is the centre of the circle SDLP, the angle SyL at the centre standing on the same part of the circumference SDL as LPS is therefore double of LPS. Now SyL, or the angle at y towards D, equals 236°, the angle at y inside the triangle SyL having been made equal to 124°, therefore the angle LPS equals $\frac{236}{2}$° cr 118°, the angle required; and because x is the centre of the circle LPBC, the angle LxC at the centre standing on the same part of the circumference LC as LPC is therefore double of LPC; now LxC by construction equals 150°, therefore LPC equals $\frac{150}{2}$° or 75°, the angle required.

A third circle may be drawn through C and S, its centre being on the opposite side of the line CS to that of the station L, having an angle at the circumference equal to 167°, or 360° − (118° + 75°); this circle, by cutting either of the others more directly, determines the point P with greater exactness.

In working for practice the above examples should be solved by calculation as well as construction.

The position of a ship may always be found by the method shown in Diagram 3, or by the intersection of the circles, but in many cases with one large angle (but less than 90°), and a small angle, or with two small angles; the method shown in Diagram 2, however, will be found more convenient.

Care must be taken that the objects used in fixing a position are situated in such a manner that the centres of the circles used in the 3rd Diagram to find the point P are sufficiently remote, as otherwise the circumferences will so nearly coincide as to render it difficult accurately to determine the points of intersection; or that in the 2nd Diagram, D and L are sufficiently remote to ensure the true direction of the line DLP being accurately ruled, as if these points fall too near to each other, a small error in the observed angles will cause a large difference in the position of P; and if the point P cannot readily be found by projection, be sure that no station-pointer or tracing-paper can more easily discover it, and an inexperienced surveyor may bring on board a chart on which the positions of shoals may be erroneously placed, owing to his trusting to three points so situated as to fully mislead him.

On the Circle.--The 4th Diagram may serve to illustrate the difficulties alluded to. It is an instance of a position in which the inexperienced occasionally find themselves known technically as "on the circle."

This occurs when the positions of the observer and of the objects observed, lie actually or very nearly on the circumference of one and the same circle. In the 4th Diagram for instance, the circle passing through C, L, and S, passes also through P, the observer's position; the angles being 15° and 57°. The small angle LSC is therefore equal not only to LPC, but, to any angle in the segment CPSL. In like manner, the large angle LCS is equal not only to LPS, but to any angle in the segment LCPS. Laying off the angles on the opposite side of the line CS, as in the second diagram, to find point D, the triangle thus projected must coincide with the already known triangle SLC, and point D coinciding with point L, no line of direction

DLP can be drawn. If the method of the intersecting circles in the 3rd Diagram is used, the centres x and y must also coincide, because the objects and the position of the observer all lie on the circumference of the same circle.

Round the segment CPS, endless time may be wasted with station pointer or tracing paper in a fruitless endeavour to find the position of P, because, as shown above, CL and LS must subtend angles of 15° and 57° respectively, to any point taken in the segment CPS.

No other object being in sight, the only friend is the mariner's compass, as a bearing taken of one of the points, as of C, N.E., by E., can alone fix the position of the wandering angles.*

In the selection, therefore, of three points to fix a position by, the middle object should, if possible, be the nearest to the observer, or the three objects should be in or near the same straight line, or the observer's position should be within the triangle formed by the three points. But in all cases of doubtful or badly placed points, a third angle, if it can be obtained, or a simple compass bearing of one of the objects, should always be taken.

The 4th Diagram will also show the advantage of using what may be termed a danger angle. Thus, if a rock, the "Torpedo," is known to lie off a coast that has been fairly surveyed, and of which the points can be recognised with certainty, then by taking care on passing the neighbourhood not to increase the angle subtended by too well-defined points as C and S beyond a certain number of degrees, in this case 72°, it will be impossible to approach the shoal. An angle of this sort measured between the Carnero and Frayle towers would have prevented the "Agincourt" touching the Pearl rock; and had the "Lord Clyde" been kept with Pantellaria subtending four to five points, instead of being allowed to close the island until it subtended eleven points, her narrow escape from shipwreck would have been avoided.

Practice on Board Ship.—When making a passage, let every opportunity be taken of observing for time, latitude, and variation. In arriving at the results, avoid applying to the Navigating Officer for such matters as the course and distance between sights and noon, but obtain the required data from the deck log-book, and compare the position thus found, with that entered in *the* log-book. By night the stars should be studied, the names and positions of the principal learnt, and on moonlight nights latitudes from altitudes of stars north and south of the Zenith obtained, with frequent observations in the northern hemisphere of the Pole star.

Time should be found by observing stars just before sunrise or after sunset.

Lunars taken both east and west of the moon, form capital practice in taking angles and using the sextant in awkward positions. The working out of all the above observations affords excellent practice in figures. The dead reckoning should be carefully worked, and daily current found by comparison of the position obtained from dead reckoning, with that determined by observation.

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* Where a couple of angles are taken to fix a ship running along a coast, or in a harbour, a compass bearing should always be observed at the same time.

A track chart of the voyage is another useful piece of practice. I don't mean a chart copied from that in use, but one constructed for the purpose from the table of meridional parts, merely fixing upon it the land that has been seen during the voyage.

On leaving the land be careful to fix the ship and obtain a departure from which to begin the dead reckoning, and on making the land take the first opportunity of fixing the ship's position, thus obtaining an idea of the correctness of the landfall.

All the above work should be carefully entered in a sight-book and work-book, every day's doings in both books being fairly headed by the day of the week, month, and year. Many valuable observations have been lost through omitting to note date and place.

The results, viz.: course and distance run, latitude and longitude by dead reckoning, latitude and longitude by observation, bearing and distance of the nearest land, current experienced, should be fairly written out at the foot of each day's work.

A table of the errors and rates of the chronometers, and a deviation table should also hold places in the work-book.

It may be remarked that this is navigation and not surveying. The answer to such a remark is, that practical nautical surveying is the essence of practical navigation, and a constant attention and practice of the latter is a sure method of acquiring a true knowledge of the former.

Seamanship.—In the studies above mentioned the duties of the sailor are by no means to be neglected, and every opportunity should be taken of handling the ship, and observing how she may be conducted in or out of port. No man can expect to attain a trusted position as a nautical surveyor who is not a good sailor, or, to speak more exactly, pilot, knowing the requirements of a ship, and the room she wants to wear, stay, and anchor in. The first lessons of this art are to be learnt in boats—I don't mean mere boat sailing, racing, &c.—but the handling of boats under oars and sail, in fair weather and foul, allowing for the velocity of running water, picking up the ship under weigh, using the anchor, landing in a swell on a rocky, and beaching the boat on a sandy coast. No opportunity should be lost of acquiring this knowledge of boats.

The Sextant.—I have alluded to the power of the compasses and scale when working on paper, the instruments corresponding to these when working on the land or on the water are the sextant and lead-line. The sextant now common, but no less invaluable (whose inventor may be looked upon as one of the greatest benefactors to his race), is to the nautical surveyor what the mariner's compass and anchor are to the navigator and sailor.

It becomes necessary to speak thus of the sextant, because inexperienced men are inclined to look on the theodolite as the nautical surveyor's principal tool. The theodolite can only be used on shore, but the sextant can be used either on shore or afloat.

The nautical surveyor should therefore lose no opportunity of making himself thoroughly conversant with this useful instrument, understanding all its adjustments, peculiarities, causes of error; the size of angles to be safely measured with it, and the means of re-quicksilvering its reflectors.* With the assistance of the sextant, the lost end of the Atlantic cable was found, and without it no ocean can be properly sounded or telegraph cable fairly laid.

When in port, lying at anchor, a simple exercise in using the sextant is to take a round of angles, consisting of six or more, between distinctly seen objects lying nearly in the same horizontal plane, and see how near in addition they may be brought to 360°. Handle the sextant both ways, inverted as well as direct; many objects from being indistinct cannot be reflected from right to left, and the left hand object that can be reflected, must in such case be used. This is often the case in actual practice.

Every opportunity should be taken of fixing the ship on the chart by bearing and angle. Taking it for granted that the harbour in which the vessel is anchored is well surveyed, it is good practice to take angles to the different points, peaks, and islets, and laying the same off from the ship's position, to see if they agree with those on the chart. True bearings of objects, both right and left of the sun, should be frequently observed for practice, taking care that the angle measured between the sun and the object, is always double the altitude of the sun.

If angles are taken between two objects close to each other, care should be taken that they are on the same level, or that the angle measured is nearly horizontal; with large angles, it is of little consequence that the objects used are not on the same level, as the error caused by obliquity is in these cases small.

The Arc of Excess.—It is good practice to measure small angles off as well as on the arc; the arc of excess in most sextants is 5°. Observed masthead angles will generally be less than 5°, and angles of elevation taken to peaks on making the land will always be less than 5°. Taking the angles off and on the arc, adding them together, and dividing by 2, gives an angle free of index error. At sea, measuring the sun's semi-diameter, and comparing that obtained with that given in the Nautical Almanac, renders the observer dexterous in observing small angles with the sextant. If the object is clear and well defined, the inverting tube will be found of great assistance.

Lose no opportunity of volunteering to lay out targets by the masthead angle, taking the angle both off and on the arc of the sextant, that being one of the methods used in nautical surveying for determining an approximate base. When the target is moored, if time permits, get a round of angles from it; these plotted on the plan of the harbour will afford an opportunity of testing the accuracy of the base obtained from the mast head angle, taking care to fix the ship's position for the way in which she may be swung, either on leaving or returning on board. The distance of the target may also be checked by using the length of the ship, or a line drawn from her knight-heads to her taffrail as a base line. The great length of the modern ironclads presents the advantage of a large base in this direction. Two points, one at each end of the ship are taken as far apart as possible, from which two observers can easily see each other; these points should be carefully marked, and the distance between them known and noted for reference. Angles between moderately distant objects and observers standing at these points, can be taken simultaneously from each end of this base, and from these, the required distance may be obtained. This subject of "Base by ship," with useful tables, has been fully treated of by Admiral Ryder in his book, "On Ascertaining Distances from Ships at Sea," a useful little work for the practical nautical surveyor, and which is supplied to every ship.

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* See Sir E. Belcher's treatise on Nautical Surveying, page 10.

Practice of Sounding in Boats.—The lines pulled in laying out the target may be also sounded, the lead line being measured on leaving and returning to the ship. The time must in this case be noted, so that the soundings may be reduced to low-water spring-tides, as those on the chart are all given for that state of the tide. To ensure the line thus sounded being a straight line, the ship should either be kept in transit with some object beyond her, or two points that are in transit in the direction towards which the target is to be laid, should be selected before leaving the ship. The soundings obtained, compared with those marked on the chart, will give evidence of the correctness of the work.

This performance will also show that some little practice and method is required on the part of the man heaving the lead from the boat, and also on the part of the Officer, to determine, first when an "up and down" cast can be obtained without lying on the oars, and secondly, when it may be necessary to stop the boat altogether. In the boat, as in the ship, the end of the lead-line should always be secured before beginning to sound, and care should be taken that "a boat's lead" is taken from the ship for this work, with the necessary tallow for arming, as the nature of the bottom should always be noted.

Measuring Distances by Sound.—The morning and evening gun fired at most ports will afford an opportunity of practising measuring base by sound. The ship being fixed, her distance may be measured on the chart from the fort where the gun is fired, and compared with the result obtained by noting the interval of time between the flash and report of the gun. (See page 729.)

The Standard Compass.—No opportunity should be lost of being present when the ship is being swung for local deviation. The practical rules for ascertaining and applying the deviations of the compass caused by the iron in a ship should be carefully studied, the Officer thereby acquiring a thorough knowledge of the use of that heart of a ship, her standard compass. This instrument is of the greatest assistance in examining a portion of a coast, making a rough sketch of a bay or harbour, or sounding round islands and shoals that may require examination in the course of a voyage.

Artificial Horizon.—In using the artificial horizon care must be taken in pouring out the quicksilver. Sir Edward Belcher, at page 8 of his "Nautical Surveying," gives the following useful hints:—"Place the "finger over the orifice of the bottle, and give it a shake in an "inverted position, holding it over the trough previously cleaned. "Ease the finger, and allow the mercury to flow gently, keeping the "bottle inverted, and taking care to stop the opening of the bottle "before the last portion with the dross flows. This will produce a "clear brilliant surface."

In pointing the horizon towards the sun, see that the shadow is thrown directly behind it, and not on either side. The spot chosen for making these observations should be sheltered from the wind, and, to be free from vibration, removed from traffic. The roof of the artificial horizon should be so placed that the same part is always towards the observer. A mark may be made on the glass or on the frame work to insure this precaution being carried out.

Observations at Night.—Obtaining latitudes at night with the artificial horizon requires some practice; see that it is placed in the true meridian before the observations are commenced. A handy man should be trained to hold the dark lanthorn, by which the observations must be first noted by the watch, and then read from the sextant, in such a manner that, while the assistant who is taking time can see the watch, no light is thrown in the direction of the artificial horizon. On the time being secured, the light is taken to the observer with the sextant. Practice is required both in holding the lanthorn and in reading off.

Astronomical Observations.—Every opportunity should be taken to practise the rating of chronometers by equal altitudes, failing that, by a.m. or p.m. sights, taking care to work a.m. with a.m. and p.m. with p.m. In making these observations, the eye-piece of the inverting tube should, if possible, be used instead of the shades of the sextant; if shades are used, endeavour always to use the same. The meridian altitude of the sun should be taken with the eye-piece, as the latitude obtained from it can then be meaned more satisfactorily with those determined by the stars.

To obtain latitudes from sun and stars, circum-meridional altitudes are generally used, taken from 20 minutes before, to 15 minutes after, the meridian passage, working them out by the method given in Inman's Tables, Introduction, page IX. The approximate mean times of the meridian passages of sun or star should be calculated from the "Nautical Almanac," the error on mean time of the watch in use should then be applied to them; these times of the meridian passage of sun or star, as shown by the watch in use, should be entered in the sight book as a guide to the observer. When at sea, stars of the first magnitude are generally taken; but on shore those of the second magnitude may be advantageously used. The study of the position of the stars at sea, before advocated, will now be found of the greatest assistance.

In the northern hemisphere, several sets of observations of the Pole-

Star may be taken to work against latitudes from meridian altitudes of stars south of the zenith. In the southern hemisphere, stars both north and south of the zenith must be taken, and the latitude determined from their mean result.

The watch used on these occasions should for the day be carried in a box, and not kept in the pocket, care being taken to compare it with the standard chronometer on leaving and returning to the ship both in the forenoon and afternoon.

Drawing is a useful accomplishment to a surveyor, but the mistake must not be made that a draughtsman is a surveyor. Sir Edward Belcher has remarked that "any draughtsman can make a neat showy "plan, but it is useless if it cannot stand the seaman's test." If the Officer has a natural talent for drawing, let him by all means encourage it, copying plans of ports from published surveys, and practising the signs and abbreviations adopted in the Admiralty charts and used by the Admiralty draughtsmen, in all cases confining his abilities to the bare facts before him. Few mistakes are more mischievous in a survey than those committed by the accomplished draughtsman who allows his fertile fingers to wander from his facts, and to produce a *pretty* plan instead of a *trustworthy* survey.

Sketches of headlands should be made on leaving and making the land, taking care that magnetic bearings of well-defined peaks and points are always obtained and inserted on the sketch. Sketches of leading and clearing marks are also most valuable, the magnetic bearings being written against them. In harbour, panoramas from the ship should be drawn, the surveyor confining the work to the land only, and avoiding sketches of boats, or shipping, remembering that the object in view is not a picture, but a ground plan or survey of the port.

When sailing along a coast, it is good practice to observe how the points, peaks, and prominent features of the land change their aspect with a change of bearing. To know a place as the same when the bearing has changed some eight points, is a difficult matter to beginners, but is of great value in nautical surveying. This knowledge may be acquired by vigilantly watching the prominent points and observing the gradual change. Although mistakes will frequently be made, and the most promising points turn out failures, becoming lost and undistinguishable, yet those that are recognised will fully repay the trouble bestowed upon them.

Equipment of Boat.—It is supposed that a boat has been granted for the purpose. Care should be taken in her equipment. Dockyard rigs are the best, and all fancy rigs should be avoided. A spare hand should be asked for when sounding is to be undertaken. The following list of gear will be found useful:—

Two leads and lines, the latter marked to feet as far as 5 fathoms, one line being 40 fathoms long; the leads, one to weigh 14 lbs., and the other 7 lbs.; a spare lead of 7 lbs.

Anchor, with cable of 30 fathoms,

Yoke lines sufficiently long to allow of the boat being steered by the feet.

Bag of lime, whitewash-brush, bucket, and bailer. Slow-match. Matches. Strand of junk for stops. Old canvas or old black bags to make marks on the shore. Tallow for arming.

Two slung 56 lbs. pigs of ballast for mooring-buoy. An axe and crowbar.

Boat's compass, pocket compass, sextant; patent log fitted, so that the box part may be lashed on to the gunwale of the boat, a longer fly line being required; note book, sketch book, drawing instruments, small board, tracing paper, penknife, india-rubber, haversack, telescope or binoculars, watch, pocket sextant, slings for sextant box, and a station-pointer if it can be obtained.

Two barécas, one with water and one fitted as a buoy.

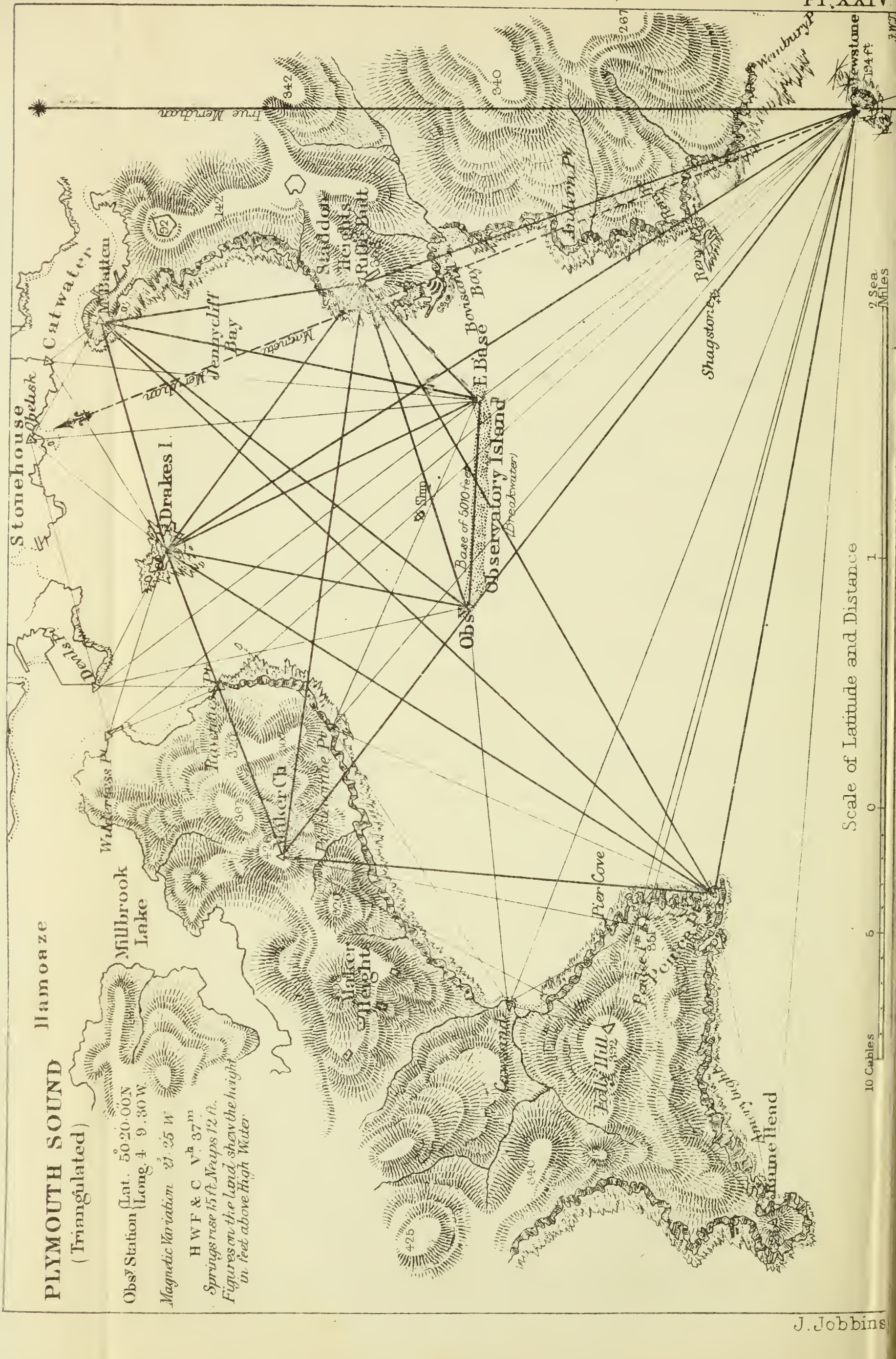
Practical Hints.—As there is generally a little climbing to be done in nautical surveying, and as there may be difficulties in landing, it is advisable to have the sextant case, glass, &c., fitted with slings to put over the shoulder, the note book, &c., should be kept in a haversack to be carried by the Officer. This ensures the hands being free in climbing, landing, and embarking. If instruments are being carried in the boat, they should be placed on the gratings at the bottom of the boat, and not on the thwarts, thereby avoiding the risk of injury from falling. Cushions and all dandy gear should be left on board the ship, as they will only be found in the way. The men should be in clean working dress, with blanket frocks in the tropics, and trained to be handy in taking off their shoes, not to be afraid of wetting their feet if necessary in landing or embarking, the Officer setting the example, being as ready to risk his comfort in surveying as he would be in shooting. Gun, powder, and shot had better be left on board the ship, the gun complaint being very dangerous to the real success of the nautical surveyor.

The Boat's Crew.—It will be of great assistance to an Officer thus training for practical surveying, to study the men who compose his boat's crew.

Let him make himself acquainted with how far they can fairly pull in a day's sounding, exercise them in lowering and hoisting the sail, tacking, and wearing, getting the mast up and down, as smartness in these matters will often give them a spell from the oars, and enable the Officer readily to find the position of a shoal cast, obtained in a line of soundings.

Without descending to what is called philanthropy, courting popularity, interfering too much with their domestic arrangements, or in any way departing from the necessary discipline of the service, let him interest himself in their habits of comfortably getting their breakfast before leaving, and their supper on returning to the ship. As taking their dinners already cooked away in the boat greatly facilitates the work, let him at first see they get their gear into the boat for this purpose, so as not to find when three miles to leeward of the ship that the rum, biscuit, or water has been left behind.

Pl. XXIV.



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and in erecting stations, care should be taken not to place them in positions where they are likely to be shaded from the sun.

In carrying on the survey, work as much as possible with the sun at your back; thus, in the Sound, the angles should be obtained on the eastern shore in the forenoon and on the western in the afternoon.

The result of the first day's work has been to fix upon the following prominent points on which stations have been erected where the position is not sufficiently marked by natural or artificial means (see Plymouth Sound triangulated) :—

The Mewstone, the Shagstone, the rifle-butt on Staddon Heights, Mount Batten, Drake's Island, the Hoe, Devil's Point, Ravenness Point, Picklecomb Point, Maker Church, Cawsand, Penlee Point, Folly Hill, Rame Chapel. The Breakwater Lighthouse, will be named as the Observatory Station and the Beacon the east base; the supposed beach between these two stations on Observatory Island affording at low water an eligible flat on which to measure the base.

Surveying a port where the names are unknown, points, islands, bluffs, &c., taken as stations, should all be named, and the practice of lettering or numbering be avoided; naming each station after some incident connected with it or its character, as Cliff Station, Beach Station, Bay Island, Leading Hill, Bald Mound, or Dead-tree Bluff; this precaution will be found of great assistance to the memory in the course of the work.

Observing the Angles.—Starting as early as possible from the ship for the Mewstone, so as to work on that side of the Sound in the forenoon, the soundings between the East base and the Shagstone give indications of shoal water in that channel. Arrived at the Mewstone and the summit gained, a true and magnetic bearing of some low but prominent station as the Observatory, is the first thing to be obtained. The rifle butt on Staddon Heights is then evidently the best object to reflect round and use as a zero or initial point of the angles to be measured, taking care not to reflect it to objects at the water-line that are within 20°; such, for instance, as East base, as in that case the obliquity of the angle may introduce an error.

Angles are then measured to Drake's Island, Devil and Wilderness Points, which will make as entrances to Hamoaze. Ravenness Point, which will probably show out black against the trees behind it; Picklecombe Point, distinguished by its fort; the Observatory Station; the Shagstone, Maker Church, Cawsand, Folly Hill, and Penlee Tower (which two last will be nearly in line), Penlee Point, and Rame Chapel: East base will then be reflected to the Observatory, thus completing the angles to stations from the Mewstone.

Angles will next be taken between the Observatory and the tangents* under Staddon: thus Reny Point will be reflected to the Observatory, then each side of the island off it, then Staddon Point, which will be probably seen over Reny Point, the words "seen over" being written in the angle book. The nearest part of Wembury Point, the bight between it and Reny Point; the bight of Bovisand Bay also "seen over," and the east tangent of Observatory Island. The rifle butt may now be used and taken to prominent points on the Cawsand Bay shore, such as bluffs, cliffs, patches of sand, conspicuous houses, extremes of beaches, and anything that there may be a probability of again recognizing. The coast guard under Lower Hams, the rocks at Pier Cove, will probably show out. The cliff at Amory Bight, the neck of Rame Head and its outer tangent will complete this part of the work. A few angles should then be taken to the prominent hills and their shoulders, the run of the valley behind Cawsand, and the fall of the hills over Ravenness, so as to give some idea of the topography. A rough plan should be sketched of the Mewstone and its vicinity with the rocks off it, lines being taken to the little Mewstone.

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* Tangent is a term used in surveying describing a line drawn from the eye to touch the points of the coast, or the edges of reefs or shoals; an angle being measured between that line and one drawn to a station or fixed point.

The Shagstone will next be visited and a few angles taken to ensure giving some idea of the adjacent coast. From the Shagstone, pull as close along the shore as possible, sounding, noting the courses steered, the distances run, and sketching the nature of the shore. Arriving at Staddon Point, the heights must be ascended, and angles taken from the rifle butt on the same system as that pursued at the Mewstone; taking care to stand as nearly as possible in the position or against the same part of the butt, to which, and from which, the angles taken at the Mewstone were reflected. In visiting the other stations similar care must be taken, as it is of the greatest importance that the angles should be measured from the exact point to which they were taken; Mount Batten will here form a good object to reflect as far as Penlee Point, after which Penlee Point itself should be used to get the angles round to the Mewstone. In thus shifting the object reflected, care must be taken that such objects are always connected; in this case, for instance, the angle between Mount Batten and Penlee must be carefully measured.

Angles are then taken to the bight of Jenny-cliff Bay, the high and low tangents of Drake's Island, with the cliffs, bluffs, houses, and conspicuous points taken from Mewstone. From the rifle butt a panoramic sketch of the Sound should be made to the best of the Officer's ability; never mind how rough may be the production, it will often serve to remind him of points in the work and prove most useful to him in projecting the survey.

Mount Batten will next be visited, the coast between Staddon and Mount Batten being pulled along and sketched in as before. Maker Church will here form a good point to reflect, taking care to use the Observatory when observing to points, &c., under the Church, and also to observe from that part of Mount Batten to which the angles were taken.

Thus each station will in turn be visited, the angles obtained, and the coast pulled along and sketched in between.

True and magnetic bearings should if possible be observed from one of the stations in the afternoon, to check those obtained from the Mewstone in the morning.

It should be arranged, if possible, that the angles from one of the stations visited in the day should be taken at low water, when, what is called low-water tangents, or lines from the station to the low-water extremes of the coast with its rocky or sandy points and beaches, should be obtained.

If in the port during spring tides, the greatest trouble should be taken to obtain these necessary lines from at least three prominent positions.

Getting out the Triangles.—Supposing that all the stations have been visited and the angles obtained, the next process is to get out the triangles it is intended to use, commencing with one of the largest, in the following manner:—

TRIANGULATION OF PLYMOUTH SOUND.

No. of triangle.	Stations.	Angles observed.		No. of triangle.	Stations.	Angles observed.	
		°	′			°	′
1	Mewstone	59	55	7	Rifle butt	38	00
	Penlee Point	40	45		Penlee Point	55	20
	Rifle butt	79	20		Maker Church†	86	40
		180	00			180	00
2	Mewstone	46	40	8	Drake's Island	63	30
	Penlee Point	68	50		Rifle butt	54	35
	Drake's Island	64	35		Observatory	62	00
		180	05			180	05
3	Penlee Point	28	05	9	Drake's Island	115	55
	Rifle butt	66	15		Mount Batten	36	50
	Drake's Island	85	40		Observatory	27	15
		180	00			180	00
4	Drake's Island	52	26	10	Drake's Island	80	15
	Rifle butt	44	45		Mount Batten	62	45
	Mount Batten	82	45		East base	37	00
		179	56			180	00
5*	Drake's Island	138	00	11	Observatory	83	40
	Penlee Point	10	46		East base	60	35
	Mount Batten	31	15		Drake's Island	35	40
		180	01			179	55
6	Mewstone	27	00	12	Observatory	21	55
	Penlee Point	96	00		East base	130	35
	Maker Church†	57	00		Rifle butt	27	30
		180	00			180	00

And so on for the minor stations.

* Ill-conditioned triangle. † Calculated angle.

As some points in a survey, although they may be prominent positions in the plan, are likely to be inaccessible, trees or other causes preventing the angles being observed from them, triangles which have one of these stations at their angles are said to possess a calculated angle, as such angles can only be obtained by that method; greater care is therefore used when taking an angle to a place that cannot be visited. In this survey Maker Church and the Folly Hill are fixed by calculated angles. In tabulating the triangles, such angles should be written in red ink.

It is evident that if the angles have been correctly taken at the several stations that the sum of these angles will be for each triangle 180°. Instrumental error, obliquity, personal error, and other imperfections generally prevent this happy result, and the Officer may be content if his sums are not less than 179° 55′ or more than 180° 5′.

The method of getting out the angles of these triangles is as follows:—In triangle (2) at the Mewstone, Staddon rifle butt was taken to Drake's Island, the angle being 13° 15′, and then to Penlee Point; the angle being 59° 55′, from which 13° 15′ being taken, leaves 46° 40′, the angle required. This process may be termed the reduction of the angles. But it may be asked, why was not Drake's Island taken at once to Penlee? Because Drake's Island, having the buildings of Plymouth behind it, was a bad object to reflect and the rifle butt was a good object to reflect; also it was not advisable to shift the zero.

At Drake's Island we have Penlee Point taken to the Mewstone, Penlee being a good object to reflect, and at Penlee we have Mewstone taken to Drake's Island for similar reasons.

In some of the triangles the angles will be found at once in the angle book, and from most of the stations used in the triangulation the angles required will easily be obtained by simple reduction. If these calculations are made at the main stations in the course of the work, much after-trouble and vexation will be prevented. For instance, if in getting the angles at Penlee, having already observed the angles at the Mewstone, the rifle butt, and Drake's Island, the triangles Nos. 1, 2 and 3 are proved on the spot, the angles at Penlee are at least certain of being taken correctly, and any error will be known as not to have been made at that station. At the same time the numerous small sums required to be worked will show the necessity—remarked upon in the commencement of this paper,—for the would-be nautical surveyor educating himself downwards, and mastering such simplicities as every-day arithmetic; thus the roots of his work, like those of the oak, penetrating the soil more deeply than those of other trees, ensure to his labours a solidity and durability similar to that attained by the monarch of the forest.

All the angles of the triangles having been sorted in the above manner, any error in the observation will be readily detected and such triangle scored as faulty; the angle wherein the error lies may possibly be detected in the course of the work. Triangles having an angle in them of less than 25° are to be looked on as ill-conditioned, and more than usual care should be taken in laying off and ruling a line *likely to cut another at a less angle than* 25°.

Projecting the Triangulation.—The work taken from the ground, or the angles and observations obtained by the above system, has now to be projected or placed upon paper. Drawing-paper of the size required may be stretched in readiness. This process is well described by Heather in his Treatise on Mathematical Instruments, page 64 of the seventh edition.* It is a good plan to first form some idea of the bay or harbour by a rough plan projected on a sheet of common cartridge paper.

A prick made on the lower right hand corner will represent the Mewstone, through which draw a long straight line parallel to the perpendicular edge of the paper to represent the true meridian, and another line at an angle of 21° 25′ to the left for the magnetic meridian. The true bearing of the rifle butt, N. 19° 15′ W., obtained by reduction, or its magnetic bearing, N. 2° 10′ E., if no true bearing has been obtained, is next laid off. An estimated distance of the rifle butt from the Mewstone has been formed by its being about as far from the Mewstone as the ship, which latter distance (Mewstone to ship) was determined by mast-head angle. Using this as an approximate base, the rifle butt is taken at 2¼ miles from the Mewstone, which at 6 inches to the mile equals 13½ inches; a prick is therefore made on the line drawn to the rifle butt from the Mewstone at that distance to represent the rifle butt.

At the Mewstone an angle of 59° 55′ is next laid off from the line to the rifle butt, in the direction of Penlee Point. At the rifle butt an angle of 79° 20′ is next laid off from the line to the Mewstone in the direction of Penlee Point, the intersection of these lines if carefully drawn will be Penlee Point; on this intersection the protractor should next be laid and the angle measured on the paper between the Mewstone and the rifle butt; if this is 40° 45′ the work is right, a prick should be made in the paper to represent Penlee Point, and the projection may be proceeded with, but do not leave Penlee Point without feeling sure that the angle between the Mewstone and rifle butt measures, as nearly as the protractor will show, 40° 45′, which was the angle observed there.

From the Mewstone and Penlee Point the angles 46° 40′ and 68° 50′ are next respectively laid off and the converging lines drawn, their point of intersection will be Drake's Island; here repeat the operation of testing the angle at Drake's Island, being sure it contains the proper number of degrees, viz., 64° 35′. Four points, the Mewstone, the rifle butt, Penlee Point, and Drake's Island, now appear on the paper. The work is further tried by another test on the following plan:—At Drake's Island the angle measured between Penlee and the rifle butt was found to be 85° 40′; 85° 40′ is accordingly laid off at Drake's Island from the line to Penlee Point and a line drawn to the rifle butt; if this line does not fairly pass through the prick in the paper representing the rifle butt some error has been made, and the work must be carefully gone over again to discover the mistake. Should it pass fairly through the rifle butt the work may be proceeded with, but woe to the tyro who fails to insure the accuracy of his first four points.

Maker Church, Mount Batten, the Observatory, and East Base are next fixed on similar principles, and then the minor stations, until the whole network of the triangles is laid down, remembering that no station can be considered as fixed before it has been fairly cut in from three or more well-determined stations.

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* A useful work to the practical nautical surveyor, published at 1*s*. by Virtue Brothers and Co., 1, Amen Corner, Paternoster Row.

Caution.—This is main triangulation, and if this is carefully and honestly projected, the rest of the work will fall into its place with ease, and that important part of the survey, the soundings, will be readily laid down; but no words can express the confusion worse confounded, the chaotic mixture of right and wrong, the untold annoyance, vexation, loss of temper, and temptation to fudge that will assuredly arise, if in these apparently minor and simple details, the greatest care is not taken, and every effort used to insure accuracy, in thus laying the foundation of the work.

Straight Lines.—I dwell forcibly on these common place matters, apparently adapted to the simple capacity of the industrious, from observing the difficulty most beginners find in drawing a straight line. To draw a long straight line requires all the attention of the practised surveyor. Heather, in his treatise on mathematical instruments, at page 66, gives some excellent rules on drawing lines. Rulers must be tested to see that they are straight, and surveying vessels are supplied with a plain steel ruler, known as a straight edge, used solely for the purpose of drawing straight lines.

To ascertain that a Ruler is Straight.—Carefully draw on a flat table between two points marked on the paper a line nearly as long as the ruler, first with the edge of the ruler turned towards you, and then with the edge of it turned from you. If the ruler is true the lines will coincide, but if not they will enclose a space.

Detail.—From the fixed stations the angles taken to conspicuous houses, trees, peaks, and cliffs, with the tangents of the points and islands, and the lines to the bights of bays and extremities of beaches are laid off, cutting the objects in, if possible, from three stations, the islands being drawn within the limits enclosed by the tangents, as in the case of Drake's Island and the Mewstone; such secondary points fixed, the coast line sketched in the boat while pulling round the sound from station to station, will be easily laid down. The fixed peaks, with the panoramas sketched from two or more points will permit of some idea of the topography being given, and thus the detail of the work will be completed.

Sounding.—We now come to the most important part of a nautical surveyor's duty, on which his character mainly depends, viz., the soundings. Without these figures the work before described is of little service to the sailor. A plan of a port without soundings may be compared to a pretty purse with no coin in it, useful only to him who knows how to fill it.

The importance of sounding is not sufficiently considered by young surveyors. They have a superstition that any fellow can sound, and

Officers wishing to obtain an insight into nautical surveying have been disgusted at being sent to learn to sound. But while the land work may be done by the soldier or civil engineer, the sounding is the sailor's portion, requiring all the ready wit and tact of his profession. In sounding the sailor has to manage air and water, the rise and fall of the tides, the velocity of currents, and to fit in his work to suit wind and weather; these forces becoming firm allies to the man who studies them, and foes only to him who knows not how to use them.

The Lead Line, by means of which the soundings are obtained, should be looked upon and treated as a valuable instrument, and, therefore, to be used for no other purpose but sounding, except in the absence of a chain for measuring a base line, or ascertaining the height of a cliff.

A good plan is to take for this purpose a ship's line that has been some little time in use, and is therefore well stretched, marking it to feet as far as five fathoms, on the same principal that the ordinary line is marked to fathoms, with 2 knots at 20 feet, and a bit of leather at 4 fathoms, or 24 feet.

The line should be always measured on leaving and returning to the ship. If obliged to use a new line, and shoal water is found, the line should be remeasured in the boat, on the boat-hook marked to feet * Men should be accustomed to heave the lead from the boats, and should be narrowly watched when fresh at the work, in order to ensure their giving the correct soundings. The foremost awning-stanchion shipped forms a good support to the leadsman's breast rope. The end of the lead line is to be secured before beginning to sound, and care should be taken that all hands take a fair turn at the lead.

Noting.—The soundings should be noted at equal intervals and distances. If a patent log cannot be obtained, this must be done by the judgment of the Officer, by time or strokes of the oars. Under five fathoms the lead should be hove continuously, and the boat's position fixed near the three and five-fathom line at low water on approaching and leaving the land.

A space must be left underneath the figures of the soundings in the angle book in which they may be reduced to low water by a table derived from observations made on the tides, to be presently treated upon. The reduced soundings should be noted in red ink.

The time should be noted whenever angles to fix the boat's position are taken, or at least every half hour. In the absence of a watch, if working within sight of the ship, permission should be obtained for the signal man to hoist a numeral flag every hour, showing the number of the bells struck, keeping the same flying for five minutes, and hoisting the dinner pendant at noon.

Attention in the notation of the time is not only a great assistance to the memory when plotting the soundings, but without it that most delicate and important part of a survey, the reduction of the soundings to low water, cannot be honestly carried out.

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* The line should always be marked from the heel of the lead.

The nature of the bottom should be frequently noted, especially marking any changes that may occur, such changes often giving warning of neighbouring shoals.

Selection of Points.—The diagrams treated on in the early part of this paper explain the means whereby the soundings are fixed, as by them has been shown what points may be considered as good, indifferent, or useless. The angles should be taken either to stations or to points fixed in the survey. When ill-conditioned angles are unavoidably used, *i.e.*, if the objects taken lie in any way near the circumference of the circle that passes also through the position of the boat, or when there is any doubt regarding either of the points, a third angle or compass bearing should be obtained as a check. In fixing the boat's position, the angles should be taken as nearly as possible at the same time and in the same place; the points to be used being looked for before reaching the position to be fixed. Sounding in a tide way, or with points difficult to distinguish, it may be necessary to anchor to obtain the fix.

Lines to be Run Parallel.—The lines of soundings should, if circumstances permit, be run parallel to each other, the distance apart being determined by the locality, the nature of the bottom, and the scale on which the plan is being made. In Plymouth Sound, for instance, the outer lines are three cables apart, the inner lines two cables apart.

To ensure these lines being pulled or sailed as straight lines, before starting from a station or fixed point, some well marked object should be found on the shore in line or transit with the point or mark for which it is intended to steer, this second mark lying sufficiently far behind the point steered for to show any deviation from the straight line required. If pulling or sailing to seaward, the same should be looked for astern; such objects kept in transit *must* insure a straight line being followed; on nearing the shore a good look out should be kept for a third object in the same line, in case of the second mark used, dipping behind the foreland. Keeping the boat on known straight lines is the only sure method of sounding in a tide way, often enabling the surveyor to fix his position by one angle only, and is of great assistance to him when there is any difficulty with regard to the objects used.

As there is some difficulty in steering by stern marks, the use of them should be made a point for practice. In all cases the compass-bearing of the points steered for or from, should be noted.

In sounding under sail five fathoms may be obtained without lowering the sail, but if the water is deeper, the sail should be lowered if running free, or the sheet eased off when sailing near the wind, to insure getting an "up and down cast."

Baréca for Beacon.—In the list of boat's gear two barécas have been enumerated, one of which should be fitted as a buoy, with a buoy-rope of about ten fathoms made of lead-line.

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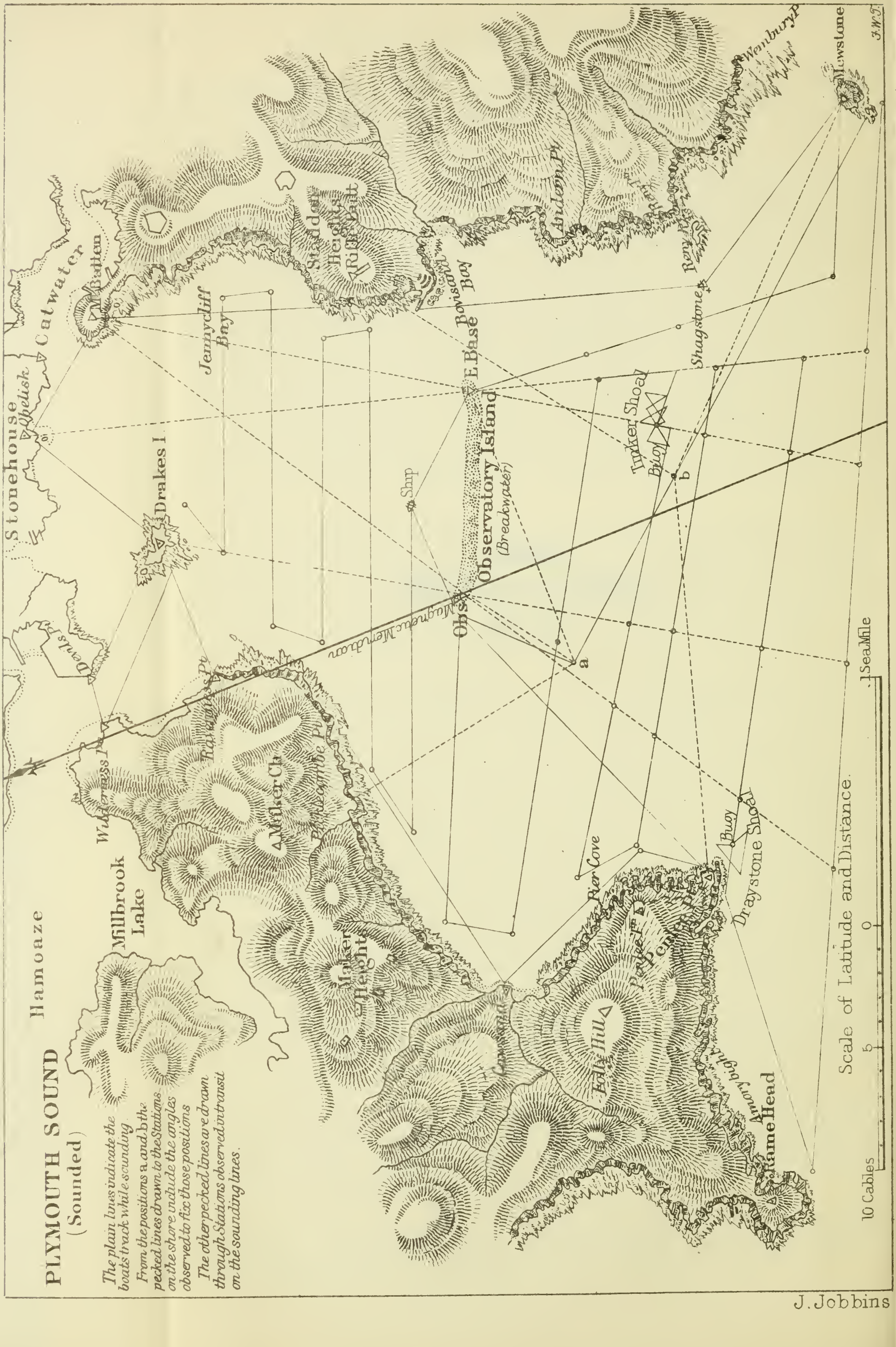
Pl. XXV.



PLYMOUTH SOUND
(Sounded)

The plain lines indicate the boats track while sounding.

From the positions a. and b. the pecked lines drawn to the Stations on the shore include the angles observed to fix those positions.

The other pecked lines are drawn through Stations observed in transit on the sounding lines.

J. Jobbins

This buoy is to be used as a beacon when it is required to examine shoal patches lying some distance from the shore, as the Tinker Shoal. The lead-line is bent on to the pig of ballast before alluded to, which will be found sufficient to moor the baréca.

Boat's Anchor.—In using the boat's anchor in surveying, where the boat may frequently be anchored on rocky ground, it is advisable to bend the cable like a buoy-rope to the crown of the anchor, stopping it with spun-yarn to the ring; then if the flukes jamb in the rock the stop will carry away, and the anchor may be weighed with ease. This precaution has saved many a boat's anchor, prevented a return to the ship, and the disarrangement of a well contemplated scheme.

Gaining Local Information.—If the bay or coast to be surveyed is inhabited, take pains to gain the friendship of the fishermen, as these men making their living by their knowledge of localities useful to themselves, but dangerous to shipping, are often able to point out the positions of rocks or foul ground. Boats or canoes fishing should be piously avoided by a vessel coasting or entering a strange port or roadstead, as they are liable to be working in the vicinity of rocks or shoals.

Plotting the Soundings.—By laying another sheet of cartridge paper underneath the rough plan, the points obtained by triangulation may be pricked through, the names written against them, and any lines of soundings already obtained should be ruled on this second rough plan to prevent the work being done twice over.

This sheet may be fixed to a board by tracing-pins and taken away in the boat, so that the lines of soundings may be laid down as obtained by station-pointer, tracing-paper, or projection. If in the absence of station-pointer or tracing-paper the work has to be done by projection, three or four stations should be selected as points liable to be used in fixing, the lines joining them ruled, bisected, and perpendiculars drawn from the point of bisection; the centres of the projecting circles would then be readily found by laying off the complement of the angle taken, from one of the points, the intersection of that line with the perpendicular giving the required centre. Thus perpendiculars might be raised upon lines joining Mewstone and Observatory, rifle butt and Observatory, Observatory and Penlee, and Observatory and Maker Church.

In the first day's preliminary examination of the sound, soundings were obtained in pulling from point to point. On returning from the Mewstone, not wanting to pass over work already done, a line was run in the direction of Penlee Point until the Shagstone coming in line with the tangent of Mount Batten, gave a good opportunity to fix the position of the boat; the next line was run to the northward by keeping the East base in line with a mark on the land; on shoaling the water three feet to the north-west of the Shagstone, that rock was observed to be in line with the north tangent of the Mewstone, on deepening to six fathoms, angles were taken, and from the East base the boat returned to the ship. (See Plymouth Sound sounded.)

The lines of soundings should all be drawn on the rough plan, to prevent the work being done twice, and all work such as main triangulation, and especially soundings, should be plotted on return to the ship, if possible before sleeping, while the memory is green. It will then be seen where further examination is required, and how the work is progressing.

It may here be remarked that if time or opportunity does not admit of making a survey of a harbour, an idea of its form, extent, and depth of water may be arrived at by simply running lines of soundings from the ship anchored near the centre, to the prominent points, noting at these points the masthead angle and bearing of the ship; thus, in the Sound, a line of soundings might be run from ship to Observatory, masthead angle observed and bearing taken, not only of the ship but of Picklecombe, then a line run from Observatory on the bearing to Picklecombe; on reaching that point, bearing of ship and masthead angle again to be taken and a line run back to ship; leaving ship again for Drake's Island, lines on the same principle could be run, returning to ship from Mount Batten, and so on till the Sound be completed.

Method of Sounding.—It is next required to fairly commence the sounding. Fine weather, with a pleasant breeze from the south-west, suggests the advisability of a day's work outside the Observatory Island to examine the entrance of the Sound. Starting from the ship for the west end of Observatory Island, the leadsman begins to sound on passing the Observatory, the boat pulling S.W. ½ S. on a line dead to windward; on this line the water suddenly shoals six feet, the position is fixed, but the examination is deferred to another time, the shoal lying near the ship and it being desirable not to lose the present good opportunity of running the long outside lines. A quarter of a mile farther on, the water again shoals 12 feet, deepening 15 in less than a cable. Another fix* is obtained, and as the ebb tide is running the mast is got up and sail made for the Mewstone, a reef being taken in to prevent the boat running too fast for the soundings. A course is shaped to keep the gap in the little Mewstone open (S.E. ½ E.) with the forts on Maker Heights in line astern; after a run of about a mile the water shoals a fathom, the bottom being rock; ship swung to the ebb is observed to be in line with Drake's Island, and the position is fixed,† and the next cast gives an increase of a fathom, making the last cast suspicious. On reaching the Mewstone the shoal to the south-west seen from the summit, when the angles were taken, is examined and the extreme fixed.

A long line is now run, N.W. by W. ¾ W., for Rame Head, keeping the tangent of the head in line with some mark on the land beyond. In the deep water to be found in this line, the sail must be lowered to get the soundings, which should be obtained at least every five minutes, and the boat fixed when favourable transits occur, such as the East

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* Position (a) on "Plymouth Sound" sounded—

East base and Observatory Station	45° 10′	fms.
Observatory Station and Maker Church.	55° 20′	6½ rock.

† Position (b)—

Mewstone and rifle butt..............	86° 40′	fms.
Rifle butt and Penlee Point	120° 50′	8 rock.

base in line with the Hoe obelisk and also with Mount Batten, the Observatory in line with Mount Batten. Arrived off Rame Head, the boat is fixed in three fathoms.

Penlee Point is then sailed for, E. $\frac{1}{4}$ S., keeping it in line with a mark found on the land near Andern Point. Under Penlee Point the fix may not be a good one, but a position will be taken up directly the Sound opens and objects can be seen. A mark on the land beyond the Mewstone having been found in line with the north tangent of the Mewstone, it is steered for, haulyards in hand, ready to lower to get the fix before spoken of; a sudden shoaling of 8 or 9 feet gives warning of a rock. Angles are taken and buoy put over and the mast got down, and the shoal starred by a method that will be presently described. The line is then continued S.E. by E. $\frac{1}{2}$ E. for the Mewstone, lowering the sail as before to get the sounding, the transits being noted and used as in the first line. The East base coming in line with the Hoe obelisk, the position is fixed and the boat run up, N. by E. $\frac{1}{2}$ E., on that line for about three cables, until Folly Hill coming in line with a gully under it, bearing N.W. by W. $\frac{1}{4}$ W., offers a good mark to stand back upon.

Just after the East base comes in line with Mount Batten the water shoals a fathom, a fix is taken, and the angles are found to be nearly the same as those taken in the rocky ground met with in standing towards the Mewstone in the morning. This ground must therefore be examined on return. Fixing under Penlee Tower the forts on Maker Heights are steered for; and after running about a quarter of a mile, the boat is fixed, and the Shagstone touching Wembury Point, bearing S.E. by E., offers a good mark to stand back upon; it being necessary to examine the neighbourhood of the two shoal and rocky casts before mentioned. A shoal cast is obtained when abreast of Observatory, giving warning of the tail of the shoal pulled over in the morning when starting, and when near the suspected locality, with Mount Batten in line with East base, 23 feet is reported.

Starring a Shoal.—It being just low water, a fine opportunity offers to examine this shoal, sail is lowered, mast got down, and a line pulled N.E. by N. for the East base. 15 feet being found, the buoy is put over and the line continued until a depth of 6 fathoms is obtained, a line is then pulled S. by E. until the boat is in 5 fathoms, back to buoy and beyond to 7 fathoms, then S.W. by S. crossing a patch of 18 feet, then back to buoy, and so on until the patch is fairly sounded out, the least water found, and its extremes determined.

The course is then continued for the Shagstone till the East base comes in line with the Hoe obelisk. Running up on this line another shoal of $4\frac{1}{2}$ fathoms is struck, making this entrance to the Sound appear suspiciously foul, angles are taken, and Cawsand Chapel in line with a mark on the hill behind affording a good mark for running west, sail is made, and a line run for those marks. Crossing the suspected ground S.W. of the Observatory Station, several shoals casts are obtained, showing the necessity of further examination of that locality.

The soundings inside the Observatory Island will be obtained on similar principles, the lines being run nearer to each other and pulled instead of sailed. Sounding round Drake's Island and the entrance of Hamoaze will give some idea of river work, the bridge representing the bar; in sounding the bridge, great care should be taken to discover a mark to lead over in the deepest water, the breadth of the channel, and the states of wind and tide in which it should be avoided.

If prevented by weather from using the board, and plotting the soundings in the boat, it is a good plan to rule the proposed lines on the plan and note in the sounding book the courses and distances it is intended to follow and the positions from which the lines should be run. Thus for sounding inside the Observatory the first line is to be run from ship W.N.W. for a mark to the southward of the redoubts over Cawsand, until the tangents of Redding and Mount Batten Points were in line; to the N.E. on that course for three cables until the rifle butt came in line with a battery beneath it, bearing E.N.E. From under the rifle butt run up two cables for Mount Batten, and then run back W.N.W. for the highest cliffs of Redding Point, heading up again two cables for Drake's Island, and so on till the lines required are all laid down. An occasional pair of angles might also be taken off the plan and inserted in the sounding book to ensure taking up the positions and running the lines proposed.

In plotting the soundings with tracing-paper, the paper may be economised and confusion of lines prevented by laying off as many angles as possible from the same point on the paper, that one point being made to take the position of the centre of the station pointer, marking each set or pair of angles laid off with some distinguishing symbol, the second set being known by a line (⟍), the third by a triangle (△), the fourth by a circle (○), the fifth by a square (□). Thus one sheet of tracing-paper may be used to lay down a considerable quantity of work.

In plotting the reduced soundings count the number of soundings obtained between two fixed positions on the line, and divide that part of the line between those stations into as many parts as there are soundings, so as to enter them evenly on the plan; in the absence of proportional compasses, the sector will assist in this performance.

When the soundings are all laid down, what are called contour lines are drawn round the coasts through the points where three and five fathoms were obtained. Draw similar lines round all the shoals, inking them in as shown in the signs and abbreviations adopted in the charts issued by the Hydrographic Office.

Although the soundings taken under five fathoms are all noted in feet, yet in plotting them on the paper they should be marked in fathoms and quarter fathoms, unless the whole of the soundings are marked in feet. Inside five fathoms the soundings should be entered on the plan to the nearest quarter fathom, outside five and inside ten fathoms, to the nearest half fathom, and outside ten to the nearest fathom.

Elevations.—From stations that are near the level of the sea, angles of elevation might be taken of objects such as Maker Church, Mount

Batten, the rifle butt, the hills over Penlee, and the redoubts over Cawsand. Seated at high-water mark, the observer may frequently detect the high-water mark directly under the objects of which he wishes to know the approximate height, and the vertical angle taken off and on the arc will give him a much better result than he can obtain by mere estimation. If the high-water mark cannot be detected, an angle taken at the water line bringing the object down to the water line will answer the purpose. The height above high water of all rocks and islets, such as the Shagstone and Observatory Island, should always be noted against them. Cliffs can often be measured by the lead line.

Astronomical Observations.—The first fine clear day after arrival should be devoted to sights, and the entire day and part of the night spent on Observatory Island. Sights for equal altitudes, latitude, true bearing, and variation of the compass should be obtained. The Officer's practice during the voyage having made him an expert observer, little difficulty is met with. Rates are obtained from observations taken from five to ten days apart, meaned with those taken at the port last sailed from, and supposing its position to be well known, a meridian distance determined in the following manner:—

MERIDIAN DISTANCE BETWEEN BEIRUT AND SIDON.

Numbers of chronometers.	Dent, 1,793. Standard.	McCabe, 187.	Frodsham, 2,714.
	h. m. s.	h. m. s.	h. m. s.
Standard fast on Beirut mean time, June 17th, 1861	7 15 00·79	7 15 00·79	7 15 00·79
Comparisons (standard being fast on chrs.)	—	9 11 15·00	9 35 15·00
Chronometers fast on Beirut mean time, June 17th, 1861	7 15 00·79	10 03 45·79	9 39 45·79
Ditto Ditto, June 11th, 1861	7 15 11·68	10 03 43·68	9 39 41·68
Rate in six days	10·89	2·11	4·11
Daily rate*	– 1·81	+ ·35	+ ·68
Sidon rates in June	– 1·91	+ ·18	+ ·59
Beirut-Sidon rate	– 1·86	+ ·26	+ ·63
Chronometers fast on Beirut mean time, June 17th, 1861	7 15 00·78	10 03 45·79	9 39 45·79
Rate in three days by Beirut-Sidon rate	– 5·58	+ ·78	+ 1·89
Chronometers fast on Beirut mean time, June 20th	7 14 55·21	10 03 46·57	9 39 47·68
Chronometers fast on Sidon mean time, June 20th	7 15 25·91	10 04 16·91	9 40 18·41
Meridian distance, Beirut and Sidon	30·70	30·34	30·73

* Losing rates are marked – ; gaining rates marked +.

s.		
30·70	Long. of Beirut. .	35° 29′ 04″ E.
30·34		− 7 39
30·73		
	Long. of Sidon. .	35 21 25 E.
177		
30·59 = 7′ 39″		

Latitude of Sidon from five observations of stars south of the Zenith	33° 34 11″ N.
Ditto by five observations of the Pole-Star . .	33 34 39 N.
Mean Latitude. . . .	33 34 25 N.

N.B.—The Sidon Observatory was at the southern end of el Jezireh.

The chronometer or watch to be used for observations should be placed in a box and carried with care. Especially avoid giving it a circular motion. The watch should be compared with the standard on leaving and returning to the ship, and all the chronometers should be compared at noon on sight days. For further information on the management of chronometers, and the measurement of meridian distances, see Shadwell on Chronometers.

Tide Pole.—A sheltered corner is found, in which the tide pole may be erected. A broken oar is driven into the sand, and supported by guys of spun yarn, or secured by stones or shot among the rocks, the place chosen being in about 2 feet water at low water, protected as much as possible, and yet with the sea having free access to it. To this oar a painted batten is lashed, conspicuously marked, the alternate feet being painted black and white, the figures 6 inches long, painted black on the white ground, and *v.v.;* such a batten can be read from some distance with a telescope. The time is noted for the rise and fall of every 3 inches, or the state of the pole marked every half hour, great care being taken to determine as near as possible the times of high and low water, by taking a mean of the times at which the water was at equal heights before and after high or low water, on the same principle that apparent noon is found by adding the times of the equal altitudes of the sun together, and dividing by 2. The state of the wind should be always noted.

If in port at the time of the full and change, it is advisable to especially observe the high and low water on that day, remembering also that the greatest rise and fall occur from the third to the fifth tide after the full or change.

On the days that are not spent on Observatory Island, if the tide pole is not near enough to be noted from the ship (which may often be done by means of a telescope), supposing the ship to be moored, and the nature of the bottom at the anchorage level, a good idea of the daily rise and fall may be obtained by noting the depth alongside every half hour with a lead-line marked to feet, taking care, as before, to obtain as nearly as possible the times of high and low water.

From one or other of these methods of observations, a daily tide table may be made, showing for every hour of the day the number of feet to be subtracted from the soundings taken to reduce them to low-water springs.

The soundings should be reduced very shortly after the return to the ship, and not entered even on the rough before they have been so reduced.

If the ship's stay is not long enough to get the times of high water at the full and change, that fact should be noted on the survey, and the rise and fall termed approximate.

A study of the Admiralty tide tables, and a comparison of the times and heights obtained, with those of some of the ports there given that at the same age of the moon have a similar rise and fall, will enable an observer to form a tolerably correct idea of the necessary amount of reduction.

To determine the rise and fall of the tide, and to reduce the soundings accurately, require very considerable tact, judgment, experience, and patience; and these must not be given grudgingly, as the knowledge of the rise and fall of a foot is often of invaluable service to a sailor in difficulties.

Measuring a Base.—To get a scale for a plan it is necessary to measure a base line. There are several methods by which this may be obtained, which, in the absence of actual measurement by chain or line, may serve to determine a scale sufficiently near for the general purposes of navigation, viz., mast-head angle already treated upon, sound, patent-log, and pacing. The last method, allowing 2½ feet to the step, is a rough method, but infinitely better than putting no scale at all, or one by estimation on the chart.

Circumstances often prevent the base being measured by chain or line, owing to absence of level ground, or even if that is found, its position with regard to the triangulation preventing its being used, in which case one of the other methods must be fallen back on. In all cases the objects or stations erected at both ends of the base must be securely fixed, and connected with the main triangulation. In the case before us, the breakwater or Observatory Island is remarkably well suited for the purpose; rarely, I fear, will a more obliging island be found.

Possessing no chain, some old well stretched lead-line, 200 feet long, is carefully marked when wet to feet, with knots at the tens, half-knots at the fives, and bunting at the fifties, an eye being spliced in each end. When it is to be used, this line must always be wetted. Ten iron pins, made like stout priming wires, should also be procured; they can be made by the blacksmith. At low water, the beach being then dry between the Observatory Station and East base, one hand (Jones) having a flag made fast to the long boat hook, is told to walk from the station in the direction of the East base for nearly a quarter of a mile, keeping a look out on Observatory Station for orders.

On being told to halt, he is beckoned to move a little either to the right or left until he stands to the Officer at Observatory Station directly in line with the East base. The boat hook is then stuck firmly in the sand, and he returns. Jones is next provided with the ten pins and one end of the line, and told to run it out in the direction of East base, by keeping the flag in line with that station. The line run out, he turns round, and is directed to shift his position, if necessary, a little either to the right or left, so as to place him directly in line with the East base; the line is then shaken, to see that it lies straight along the sand, with one end touching the centre of the Observatory Station. He is then ordered to put his pin in the sand at the bare end of the line, and to proceed in the direction of the flag and East base, drawing the line after him, and followed now by a second hand (Smith) who carries the other end of the line, walking at a pace sufficient to keep the line taut, and accompanied by the Officer with note-book. The pin reached, a halt is made; Jones turns round, and gets Smith immediately in line with Observatory, while Smith sees that Jones is in line with the East base. The line is shaken up, the bare end placed against the pin. Jones puts the second pin into the sand, while Smith takes out the first pin, and is ordered to retain it until he can muster ten pins. Meanwhile the Officer enters a stroke thus (/) in his note-book, and orders Jones to proceed as before. The second pin reached, the operation is repeated, Jones putting in a pin, Smith taking up a pin, and the Officer entering a second mark in his book. When the fifth pin is taken out, the mark is made thus (𝍸).

On Jones arriving at the eleventh length, he naturally calls out for more pins. Smith, having ten, gives them to the Officer, who, finding they correspond with the tally 𝍸 𝍸 in his book, knows the work is so far correct, and that 2,000 feet have been measured. The Officer then carries the pins to Jones, and they proceed as before.

In the example before us, the shift of pins occurs twice, and if the work is correctly done, Jones will find himself at the East base, 10 feet beyond the position of the fifth pin of the third batch. The distance between this pin and the centre of the east base is most carefully measured. Smith, taking out the last pin, returns five to the Officer, Jones having the remaining five. The score in the book stands thus:—

Observatory to East base 𝍸 𝍸 𝍸 𝍸 𝍸 and 10, or 5010 feet.

The operation is then repeated, measuring from East base to Observatory, and should agree within two or three feet.

By Mast-head Angle.—If the mast-head angle is used, care must be taken (the ship being a floating and moving object) to obtain the horizontal angles from the same mast of which the angle of elevation is being taken. These horizontal angles are taken between the station on the shore from which the mast-head angle is being measured, and two other stations, one right, the other left of it, every angle of the two triangles being above 25°. These angles should be taken as nearly as possible at the time when the observer on shore is taking the mast-head angle. Meanwhile the observer on shore measures the angle between the mast used and the two stations taken from that mast on board the ship. A flag or black ball should be hoisted close up to the truck of the mast to be used.

The station on shore from which the mast-head angle is taken should be one near the water line, so that the lower angle at the ship should be as nearly as possible a right angle.

By Sound.—The base may also be measured by sound, in which case as long a distance as possible should be used, and if guns are fired from only one end, the base should be measured on a calm day, or when there is not much wind.

The best method of getting base by sound is first to ascertain the number of times that the watch to be used beats in a minute of time. Most pocket chronometers beat 5 times in 2 seconds, or 150 beats to a minute; common watches vary. The number of beats of the watch ascertained, it is easy to find the number of feet that sound travels in that beat. That number of feet multiplied by the number of beats observed, corrected for temperature (heat accelerating the velocity with which sound travels), will give the distance required.*

To measure base by sound, a little pre-arrangement is necessary. In this case it is understood that the ship will fire three guns to the observer at the Mewstone. On the Officer's reaching the Mewstone, and being quite prepared, a flag is shown; that flag is answered by the ship hoisting the preparative, dipping it when the gun is ready. When the flag at the Mewstone has also been dipped, the flag at the ship is slowly hoisted, and the gun fired on its reaching the truck.

The flag re-hoisted at the Mewstone shows that the Officer is again ready, and the operation is repeated.

A simple method of counting the beats is by binding the watch close to the ear by means of a pocket-handkerchief; this leaves hands and eye free to use glass and note-book. The observer, comfortably placed with his eye on the ship, begins to count on seeing the *flash*, finishing with the *report* of the gun.

As in the former case, angles are taken at the same time at both ship and Mewstone to connect the base with the triangulation. The gun fired should have extreme elevation given to it; and, if possible, guns should be fired from each end of the base.

The patent-log base should, of course, be run at slack water, running the base three or four times to insure accuracy. The error of this instrument may be found by previous experiment in well surveyed ports.

An opportunity to test the patent-logs occurs when ships are running the measured mile.

The base obtained, the next step is to work out the sides of the triangles, checking the work as it is proceeded with by finding an occasional side from two adjacent triangles, remembering that the sum of the angles not being in all cases equal to 180°, the sides found will not quite agree. When one of the longest sides is found, as Penlee Point to the rifle butt, it may be compared with the number of inches found between those stations on the plan, and the scale of the chart deduced therefrom.

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* At a temperature of 32° Fahr., sound travels 1090 feet in a second; acceleration for temperature, 1·19 feet to 1° of Fahr. At 60° Fahr. therefore, sound travels 448 feet in one beat of a chronometer beating 150 times in one minute.

Shoals out of sight of Land.—If a shoal is fallen in with out of sight of land, or if a ship is sent to search for and examine a danger so placed, the vessel should, on finding the shoal water, if possible, anchor, mooring if convenient. Four boats might then be sent away to sound on north, east, south, and west lines from the ship for three miles, hoisting a flag every half hour, and taking a mast-head angle of the foremast, at which truck a black ball should be shown; an observer at the ship at the same time taking a bearing of the boat. (See Diagram 5.) At the end of the three miles distance, to be determined by mast-head angle, the boats will pull respectively E.S.E., S.S.W., W.N.W., and N.N.E. for $2\frac{1}{3}$ miles, fixing their position by mast-head angle, and hoisting their flags to allow the ship to obtain bearings of them. They will then return to the ship on S.W., N.W., N.E., and S.E. courses, sounding and hoisting their flags as before.

If shoaler water be found, requiring further or more extended examination, the launch, with her gun, should be sent in the direction of the foul ground to anchor on a given bearing at a distance of not over three miles from the ship; three guns will then be fired from both ship and launch to determine the distance. Ship will then weigh and take up a second position as convenient not more than three miles from the launch, when another base will be measured by sound, the ship beginning to fire when she has anchored. Launch will return to ship sounding, and the three remaining boats sound round the ship as before.

Coast Survey for Practice.—Sailing along a coast of which there are reliable charts, it is good practice to take angles, bearings, and true bearings, whenever observations are obtained, thus acquiring experience in examining a coast of which the charts are faulty.

Thus a true bearing from amplitude may be obtained at sunrise, with angles to conspicuous objects, noting the direction of the ship's head, the course to be steered, the patent log if in use, and the time. Another set of angles to the points taken at sunrise, and true bearing from azimuth, may be taken when the forenoon observations are obtained, other objects ahead being selected to continue the work by; a third set may be taken at noon, and the observations continued on similar principles in the afternoon and evening. Bearings of all objects in transit should be taken, and the direction of the ship's head and her courses carefully noted. If no current has been experienced, the courses steered and distances run, will form bases from which an attempt at projection may be made; or from the true positions determined by observation, the bearings and angles may be laid off, thus seeing how nearly conspicuous points could be recognized, and compared with the same points as marked on the chart.

Night Survey.—A knowledge of the system of sounding will enable an Officer under cover of the night, with the judicious use of masked

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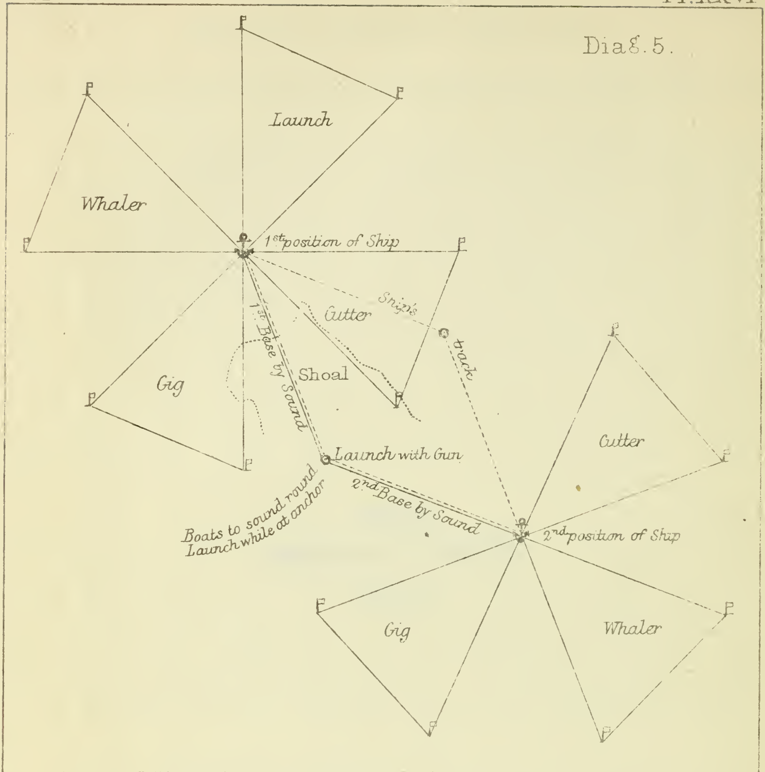
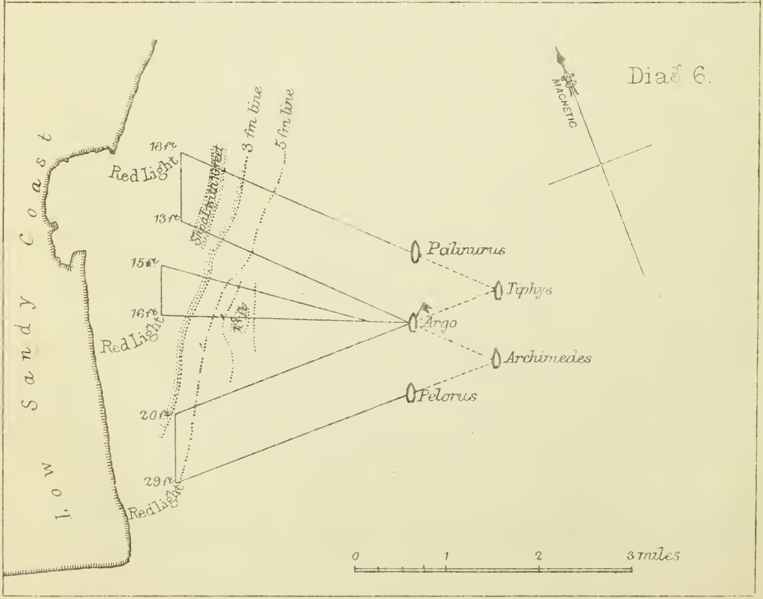
Diag. 5.



Diag 6.



J. Jobbins

lanthorns, to examine an enemy's coast, the charts of which may not be trustworthy, with a view of effecting a landing, of bombarding, or of otherwise giving him trouble.

In Diagram No. 6 a squadron of five vessels, viz., the "Argo," carrying the broad pendant of the Commodore, the "Tiphys," the "Palinurus," the "Pelorus," and the "Archimedes," are supposed to have anchored about four miles distant from the coast, on the following bearings and distances from the flag-ship:—the "Tiphys" east 10 cables, the "Palinurus" N.N.E. 7½ cables, the "Pelorus" S.S.W. 7½ cables, and the "Archimedes" S.E. 10 cables.

Immediately on anchoring, observations are made to determine the state of the tide, its velocity, time of turning, &c. The distance of the shore is found by observing angles from the "Pelorus," "Palinurus," and flag-ship, to well-defined objects on the shore, the distances the outer vessels are from each other affording a base, the same base to be measured by sound or mast head angles.*

As soon as it is dark, three boats will leave the squadron with muffled oars and other cat-like and cautious contrivances, one from the flag-ship, the two others from the "Palinurus" and "Pelorus." Each boat will be provided with the red bow-light of her steam launch,† a patent-log (the box part being lashed to the gunwale of the boat to allow of the hands being seen, the fly line being lengthened if necessary), watch, compass, lead-line, and sextant. The boat of the "Palinurus" will pull in N.W. 2¾ miles *over the ground*, keeping the lights of the "Palinurus" and "Tiphys" in transit, sounding continually, and allowing in her distance for the tide that may be running, the distance actually to be pulled being approximately determined on board the ship before leaving; the Officer in charge being required to exercise his judgment in the matter, as he will know approximately by the angle with her course, on which the boat has to be steered, to ensure her keeping the lights in line, the velocity with which the tide may be running.

On reaching her station, the boat will exhibit the light towards the flag-ship, carefully masked from the shore by jackets and other appliances, remaining in this station no longer than ten minutes.

While in this position the Officer in the boat will take bearings of the flag-ship and the "Pelorus," and if possible obtain the angle by sextant between the latter ship and the "Palinurus," avoiding the danger of reading off by stowing the sextant away with the arc firmly clamped, noting the time of arriving and leaving with care, keeping the boat in position by watching the lead.

The boat will then pull three-quarters of a mile S.S.W., or until the "Archimedes" comes in line with the flag-ship bearing S.E., when she will come back on that line sounding all the way. When sounding in-shore it may be advisable to stop the boats to sound, thereby avoiding the splash of the lead.

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* As this base may be considered small, the "Tiphys" and "Archimedes" might at first take up positions of respectively N.E. by N., and S. by W., distant two miles from the flag-ship, observers from the flag-ship visiting each vessel to obtain angles to objects previously determined upon; that done, and the bases measured, the ships would take up the positions originally assigned to them.

† Here, perhaps, Captain Colomb's inventions may be turned to useful account.

The boat of the "Pelorus" will pull in west $2\frac{3}{4}$ miles on similar principles, keeping the "Archimedes" and "Pelorus" in line; arrived at her station she will exhibit her light, obtain bearings of the flag-ship and "Palinurus," measuring the angle between the "Pelorus" and the latter ship, remain in station ten minutes, noting time of arrival and leaving with care. She will then pull N.N.E. three-quarters of a mile, or until the flag-ship comes in line with the "Tiphys," bearing east, when she will pull to the flag-ship on that line, sounding the whole way.

The flag-ship's boat will pull in W.N.W. $2\frac{3}{4}$ miles, keeping the "Argo" as near as possible exactly between the "Tiphys" and "Archimedes," arrived at her station she will exhibit her light and obtain angles on the same plan as the other boats, she will then pull half a mile N.N.E., and then S.E. by E. for the "Archimedes," keeping that ship just open southward of the "Argo" until close to the flag-ship, sounding the whole way.

Meanwhile the ships on the departure of the boats will, on a signal from the flag-ship, all hoist position lights, as if in communication with friends in the offing. A sharp look-out will be kept from the "Palinurus" for the boat of "Pelorus" showing her light, and *vice versâ*. Directly the lights are seen a bearing will be taken, and, if possible, angles measured between the boats and the flag-ship. A second look-out will be kept for the light of the flag-ship's boat, and also for that of their own boat; angles and bearings taken, and the time in all cases particularly noted.

These angles and bearings will at once be sent to the flag-ship, from which ship angles and bearings will be taken to the boats on similar principles.

Taking it for granted that this manœuvre is successfully executed, the following information will be obtained:—That the 5 fathoms line lies about three-quarters of a mile from the shore west of the "Pelorus," and $1\frac{3}{4}$ mile from the shore north-west of the "Palinurus;" that there is a distance of about one-third of a mile between the 3- and 5-fathom lines; that a shoal distant $1\frac{1}{2}$ mile from the shore lies 2 miles W.N.W. of the flag-ship, on which as little as 18 feet was found, while the northern boat found a ridge of 10 feet little over one mile from the shore. The general result of the examination has shown that foul ground lies to the northward, but that the southern part of the coast appears to be clear.

The squadron might then weigh, and taking a new position to the southward, in a similar manner renew the examination.

It may be remarked that this work could be done without the risk of exhibiting lights from the boats. The answer is the uncertainty of even practised men being able with any tide running to take their allotted positions; the difficulty of getting angles and bearings from the boats; while the bearings from the ships ensure a greater amount of accuracy in the work. Masked lights have been used with success and may be so again.

Advantage may be taken in the day time to observe from the ships the nature of the country, angles may be taken which, combined with others obtained immediately on landing, will serve to fix any elevated points, forts, or bridges. Angles of elevation to any heights may be taken and worked out, and thus some knowledge of the prominent features may be put upon paper, and prove of great assistance to the Officer in command.

For many of the practical hints contained in this paper I have been indebted to the kindness of Captain Shortland and other friends whom I have consulted on the subject, and I am free to confess that I have thereby added considerably to my own knowledge of "Practical Nautical Surveying." Admiral Ryder has also suggested the following ideas relating to the survey of an enemy's coast by night.

Steam launches may be used to run the lines of soundings, and with great advantage, owing to the speed with which they can run in, return, and escape if chased; the assumed difficulty of keeping the lead-line clear of the screws may be overcome by having a metal open framework fitted in front of, and on each side of the screw, or towing a boat alongside, from which the casts of the lead should be made.

Electric Light.—The power of throwing a beam of light, sufficiently brilliant to light up fully a ship two miles off, can, it is said, be obtained by means of the electric light. This may evidently be made very useful in aiding a night survey. Small fast steam vessels sent in on the flanks could frequently illuminate the beach and water near it, passing the beams slowly or quickly as may be thought advisable; this would draw the attention of the enemy from the surveying boats which would be pushed on in the dark space between the flank ships and between beams of light thrown by those ships on the beach.

Marking Extreme Positions.—Each boat should drop an anchor and beacon-buoy at her extreme position, which should be fixed by cross-bearings from the ships immediately after daylight, before the enemy has time to remove it.

Exercise in making Night Surveys.—The only way to ensure our being able to make useful night surveys in war time, is to practise in peace time, first by day, and then by night. The boats from ships at Spithead could be usefully exercised at making a night survey of the anchorage off Southsea Beach and the Isle of Wight, and from ships in the Sound, of Drake's Island and the beach under Mount Edgecumbe.

Signals.—The flashing signals should be used when necessary, but very sparingly, from the boats. Each boat should have a general and a special pass word.

The Colour of the Boats.—This should be light grey, to be as little distinguishable as possible.

I would remark in conclusion that although nautical surveying, from its simplicity, may seem suited to the meanest capacity, still, if real success be looked for, there is no profession that requires more straightforward perseverance and steady application. It is adapted not so much to "men of genius" as to those who possess the rare gift of industry in one particular direction, or what Carlyle calls a capacity for taking trouble, with conscientious labour, shirking and evading no difficulty, completeness of work in all its divisions, and incessant practice when opportunities offer.

I have thus, Sir, in as full a manner as the time at my disposal permitted, endeavoured to embody in my lecture the programme of the Committee of this Institution on "Practical Nautical Surveying." To fulfil the wishes expressed in the last clause of this instruction, viz., "To ensure at some future time our having on board every ship of war "one or more Officers capable at an instant's notice of undertaking a "rough marine survey," is, however, beyond my powers; with the active co-operation of the State it may nevertheless be accomplished.

We possess gunnery establishments and go to vast trouble and expense in raising a body of Officers cunning in the manipulation of the huge artillery of the day, but unable, from pressure in one direction, to give much attention to the art of navigating the wondrous platforms that carry that artillery.

The science of naval gunnery, however perfect, cannot be turned to account, without the assistance of navigation, to guide our floating batteries with confidence and security.

This fact strongly points to the necessity of extending to navigation and nautical surveying a care and encouragement similar to that which naval gunnery has so long enjoyed.

If this could be done, and a system established by which the subjects briefly treated upon in this paper could be fairly and practically taught, it would in a few years "ensure our having on board every man of war "one or more Officers capable, at an instant's notice," not only "of "undertaking a rough marine survey," but qualified to perform in their various branches the responsible duties of the pilots of the Fleet; able, as of old, to place an element of success at the disposal of the fortunate Admiral or Captain under whom they might have the honour to serve.

Evening Meeting.

Monday, 1st July, 1872.

Colonel DUNCAN J. BAILLIE, Commanding Royal Horse Guards, in the Chair.

NAMES of MEMBERS who joined the Institution between the 25th June and 1st July, 1872.

LIFE.

Clerk, Godfrey, Lt.-Colonel Rifle Brigade. 1*l.*

ANNUAL.

Bunbury, Chas. Thos., Capt. Rifle Brig.

Acland, C. T. Dyke, Lt. 1st Devon Vols.

THE BREEDING OF HORSES FOR MILITARY PURPOSES.

By Captain H. M. Hozier, Assistant-Controller, Aldershot.

It would be as useless, as it would be impossible, to attempt to describe the necessity for military purposes of maintaining a good breed of horses in a country. The fact of the necessity of the horse in war has been recognised from the earliest times, and as military science has advanced, the value of the horse in the theatre of war has been more and more appreciated. Larger numbers of horses have constantly been required in each successive campaign. It is true, indeed, that in the present day the bulk of the forces brought into actual conflict on the field of battle does not consist of mounted men at arms supported by a few foot soldiers as in the middle ages, and some enthusiasts, till the last war in France proved the fallacy of their views, actually insisted that arms of precision had driven cavalry off the field of battle altogether. Experience, however, has proved, what common sense prognosticated, that the introduction of arms of precision, both directly and indirectly, has increased the necessity of the horse for military purposes.

In the first place, the introduction of a rifled armament has necessitated a much wider field of observation and of scouting than before. A much greater extent of country must be embraced by the vedettes and outposts, both in front and flank of an army, than formerly. The movements of masses of troops, and the concentration of armies must be more carefully shrouded than of old, for now-a-days movements, when once matured, cannot readily be checked or altered, and must be carried through. A great portion of the success of the Prussians in the earlier days of the late campaign was due to the surprise with which their heavy columns burst upon the unsuspecting French. These columns had been concentrated secretly, and, during their concentration, had been entirely shrouded from the observation of the French purely by the wide screen of posts and deep curtain of vedettes thrown in front of the Prussian infantry by the Prussian cavalry. This cavalry not only entirely concealed the movements of its own armies, but, through the advantage of its numbers and organization, ferreted out and reported to its Staff every movement of the enemy.

In the second place, the introduction of arms of precision has increased the distance between the lines of battle, even in actual conflict, and the rolling of the intermediate ground affords favourable opportunity for the action of cavalry even on the field of battle. That this action of cavalry, however, much previously scouted in theory, is still of the highest importance, may be seen from the very latest experience; for at the battle of Vionville, Prince Frederick Charles, although he had only 24,000 infantry, saved the day, and prevented the passage of Marshal Bazaine and 180,000 men by the skilful use of 19 regiments of cavalry. The wide extent of ground covered by modern armies in battle affords favourable points of concealment for bodies of cavalry, whence they may dash suddenly on unsuspecting batteries or isolated skirmishers.

Again, armies now operate in much larger numbers and at much greater distances from their base of operations. Their trains of supply and stores must be much heavier than of yore, and would astonish a Turenne or a Marlborough. The introduction of breech-loading armament has greatly increased the necessary supply of ammunition, and this ammunition must be supplied by horse power on the very field of battle at the moment required. Horses must also be ready to remove the largely-increased numbers of wounded beyond the further reach of fire.

We may thus gather that the number of horses required in war will continue to increase instead of diminishing; and we can also see that broadly the horses required in war may be classed under four heads:—

1. The horse required to be ridden to collect intelligence, convey reports, and do the various duties which form the functions of light cavalry.

2. The horse which requires to be ridden and take prominent part in the actual crash of the charge, and is retained chiefly for the duties of heavy cavalry.

3. The horse required for draught and yet active enough to manœuvre, and to follow troops at a trot, or even a gallop. Such are the horses which draw the guns, the ammunition carts, the ambulances, and the first reserve of ammunition.

4. The horses which are required to trail along the long lines of communication in rear of the army; to bring up to the supply depôts the constant flow of food and stores, without which being

properly assured, the Army cannot live a day, advance a mile, or fight an hour.

For breeding purposes these might be further classified. The horse of the light cavalry and heavy cavalry may be regarded as one, for the lighter could be told off to the light, the stouter to the heavy cavalry. But the horse of the artillery and train should be kept distinct.

It seems a great error that this is not the case, as the train is generally horsed much too slightly. The horses required for train purposes ought to be great heavy dray horses, of the type of the Clydesdale cart-horse, the Suffolk Punch, or the heavy horses in brewer's drays, instead of as at present merely coarse imitations of cavalry chargers. One heavy horse would do as much work as two of the present train horses; would require half the attendance and only eat three-fourths as much.

It is very difficult to estimate the number of horses of these different kinds which our Army would require in time of war, because it is impossible to say how many troops would be put into the field. It may be, however, presumed that in case of that invasion, the fear of which alone ever induces any progress in military matters in this country, out of the regular Army at home, Militia and Volunteers, we should at least place 100,000 men in the field.

The cavalry to accompany these should be in the proportion of at least 1 to 20, or 5,000; the artillery 3 guns to 1,000, would require 300 guns or 50 batteries, of which 10 should be horse.

The light train required would be 25,000 horses, and the heavy train would require with reserves, &c., 75,000.

Cavalry—10 regiments, 500 strong, present establishment being 350 each, would require 150, or—

1,500	horses.
5,000	artillery.
25,000	light train.
75,000	heavy train.
106,500	Total.

Now the total number of horses in the country is theoretically 2,150,000, including old horses, foals, brood mares, &c. If these range from foals to 15 years old, we have an average of 143,000 of each age, or 572,000 horses between four and eight. If we had power to take all horses at once, we should be in no difficulty, but we have not the power, and if we had, it would be impossible to exert it. Fancy London, Birmingham, &c., with their horses taken away! Whole populations would starve, trade would be paralysed, and we should be actually playing the very game of the enemy.

It would be impossible to seize the whole of the available horses in the country without warning; it would be a different thing if we registered horses during peace, and told the owners we should want them in war, as in Prussia. Then owners could make their arrangements to be ready at the hour of need.

But it is doubtful, notwithstanding statistics, even if we could seize all the horses, if we should get the numbers quoted above. Nothing is so fallacious as figures, and the real practical test of the *quantity* of horses we can get is the facility of supply.

As to quality, last year for the manœuvres we had to buy 1,038 old horses avowedly only for a few weeks' work, and had to pay £38 a piece for them.

This year we are again buying about 2,000 at, I believe, £42, as well as £1 to £2 for travelling expenses.

It has been urged that the horses could have been procured young abroad, and after being kept for two months on Government forage, sold at a profit; but the Continent would be closed in time of war, or at least there would not be time to get the horses over, and it was wise of the Government, if solely from question of experiment, to determine to draw all the horses required from the horse market.

We can now see sufficiently well, that it is most difficult to get 2,000 horses in time of peace of serviceable condition, and we may confidently predict it would be impossible to find, at the sudden outbreak of a war, the 100,000 which we have seen above would be necessary for military purposes.

The worst feature of the case is, that instead of there being any prospect of improvement, both statistics and facts for once agree, and show that matters are rapidly getting worse. We see that this year we find more difficulty in getting horses than last year; we know that the prices of remounts have had to be raised, and we know from every good authority that horses are daily, and will become daily more difficult to obtain. The causes of this diminution of horses seem not difficult to perceive.

1. Prices offered in the foreign market have tempted breeders to part with their mares. In Ireland the action of the Encumbered Estates Court, by throwing the formerly small holdings into larger farms, has greatly diminished the number of mare owners and consequently of foals.

2. The breeding of the heavy cart horse which, on our present system, is not available as a military horse, pays the farmer better, as it can be worked at two years old on the farm, and is less liable to disease and accident by galloping about against fences, &c., than the more active and highly-bred horse.

3. The large exportation of the country.

4. The tendency of purchasers, especially the Government, to deal with middlemen and contractors instead of with breeders direct; a course which diminishes the breeder's profit.

Whether, however, these be the true reasons or not, the acknowledged dearth of horses makes it necessary that some measures should be taken to obtain a ready supply of horses in case of war.

Foreign countries have long recognized this. France distributed horses among the farmers in time of peace, which were to be called up in case of war; but this system at the outbreak of the last war was found not to answer.

Prussia established large studs, and also possesses the power of seizing a certain number of horses at fixed prices from each part of the country. This system in Prussia is not so dangerous as it would be in England, for Prussia is a country mainly agricultural; and in time of war agricultural operations are naturally delayed.

Till lately we had an excellent breed of horses in England. From early days the rulers of the country had devoted attention to the subject, and the climate seems naturally to have been suited to facilitate their endeavours.

In the reign of Henry the First, the first Arabian horse on record was introduced into this island by Alexander, King of Scotland, and was presented to a church; and in the reign of Henry the Second, Smithfield was already famous for the racing there of hackneys and charging steeds against each other.

John imported 100 heavy Flemish stallions, the distant sires of our now famous Clydesdales and Suffolk Punches.

Many Kings imported horses, but it was in the reigns of Charles the Second and William the Third, that the great horses, which may be regarded as the patriarchs of our present thoroughbred racehorses, were brought to this country. These were the Godolphin Arab, the Darley Arabian, and the Byerley Turk; and the blood of some one, or all of these, beats in the pulse of every horse now on the turf.

From the Byerley Turk, have sprung in direct male descent Hobbie Noble, Thormanby, Bay Middleton, Flying Dutchman, Parmesan, Caractacus, and Buccaneer.

From the Darley Arabian, in direct male descent, Touchstone, Orlando, Marsyas, Cotherstone, Lord of the Isles, Dundee, Gladiateur, Stockwell, St. Albans, Lord Lyon, Voltigeur, Weatherbit, Beadsman, and Blue Gown.

From the Godolphin, the Melbournes and West Australians.

For reasons into which it would be here tedious to enquire, it is my opinion that the more the blood of the Darley Arabian is concentrated in a horse the better he will be for what is technically called staying purposes.

Now the crucial question is, What measures are we to take to preserve, or perhaps how to improve, the quality of the breed and increase the quantity of horses available for military purposes?

We might—

(1.) Prevent exportation of all horses. This method would be clumsy and contrary to the spirit of the times, unfair to the landowner and farmer, and extremely impolitic.

(2.) Prevent exportation of mares. To this plan there are of course similar objections to the former.

(3.) We might form Government studs. This might meet the difficulty to a limited degree, but the expense would forbid all the horses we require being bred in this way.

(4.) We should certainly encourage breeders of all descriptions by dealing directly with them, and not allow a monopoly of the whole trade to fall into the hands of a few contractors.

(5.) We have seen that the horses required for the train constitute the great proportion of the horses which would be needed at the outbreak of the war. These could easily be procured at moderate cost, provided that we would only recognize that for train purposes, we should have cart horses instead of imitations of bad cavalry chargers.

Were this so, Clydesdale or Suffolk stallions might be located in the various districts of the country and open to free use by the farmers, provided that the stock were liable to be taken in case of war by the Government at a fixed price. Of course one agreement would be, that none of this stock should be sold to go abroad. Farmers would gladly consent. There are believed to be about 250,000 cart mares in England. It is probable that as a cart mare can do her farm work till within a few days of foaling, at least 100,000 of these should foal every year, and give the Government an available annual contingent of 100,000 draught horses; at the same time mares cast from the Government service, should be sold at merely nominal sums in the market towns, so as to fall into the hands of farmers—not cab-drivers—and be available for breeding. The *light* horses got by the local cart stallions would be available for the light train, perhaps even for the cavalry; the *heavy* ones for the heavy train. Stallions should be shifted from district to district every two or three years to prevent the same strain of blood being consolidated in any one district, and to provide that the species should not be deteriorated by in-breeding.

Having seen how the train horse might be procured, let us now turn to the cavalry horse. Speaking from a breeder's point of view, the horse for the heavy cavalry is the same as that for the light cavalry, for the former would only be the heavier selected from the young stock. It is my firm impression (though I believe it will be regarded as rank heresy by many cavalry Officers) that there is nothing equal to the thoroughbred blood horse, provided the thoroughbred horse has bone and substance. A good blood horse has more bone and substance than good half-breds. This can be amply demonstrated by weighing similar sections of the bones of each. People accustomed to see young thoroughbreds of two or three years old on the race-course in racing condition condemn them as weeds; but what would half-breds look like in similar conditions? It is not fair to compare the three-year old in racing condition with the pampered troop horse of eight or nine summers rolling in fat and only exercised at watering order. The way to see the thoroughbred as compared with the half-bred, is to visit some of the stud farms, such as Hampton Court, and see a furnished mare or stallion six or seven years old. It is such as these that we should wish to have as chargers for our cavalry. They would do more work, stand more fatigue, and exist on less food than any half-breds; but unfortunately the expense prevents us from getting them. We can only approach as nearly as possible. To do so we might place a certain number of thoroughbred stallions in different parts of the country for the use of country gentlemen, to whom for the cavalry horse we must look more than to the farmer; and maintain the right of having the stock at an assessed price in time of war. These sires should be obtained from the best stock of the country, and should contain as much Darley Arabian blood as possible.

But to maintain the sires that we should want, and also to obtain the horses we should wish, there ought to be at least one or two Government studs. At the present moment many good horses, such as Paganini, could be bought moderately from the turf and would act as sires; but it appears as if we could not long trust to the turf. It is impossible to deny that some excellent horses are still on the turf, perhaps a few as good horses as ever were on the turf are now in training; but the general average is deteriorating. The prevalence of short races and handicaps allows worthless horses to be retained in training which become sires and still worse dams; and although a few horses can stay well, the Queen's plates are nearly now always carried away by one French gentleman, M. Lefèvre. The Legislature might interfere here usefully. Nearly all the horses that can stay in England belong to the foreigner, M. Lefèvre. If the best thoroughbred *class* deteriorate, so must our sires deteriorate.

It would be advisable to have studs for sires, as it is very difficult to buy good sires, except at enormous sums, when once exposed on the turf. Yearlings might be sold on condition of being returned at the end of their racing career.

All good mares should be covered gratis at the Government studs, and stock liable to be taken only in case of war.

I have endeavoured to explain the ideas I have formed. They can only claim to have been carefully considered and not crudely enunciated. It will be a great pleasure to me if they may lead to a discussion and consideration of a subject which seems to me to be so very important to the nation in general and to the Army in particular.

The Earl CATHCART: I do not know, whether I, as a stranger, am entitled to say anything on this occasion. If I were allowed to do so, I would merely wish to say a very few words, to show how anxious we farmers are to co-operate in any possible way. As a member of the Council of the Royal Agricultural Society, I may say we have already taken great interest in the subject now in question. I have given my best attention to every thing that has been said by the able and gallant lecturer. Although I was prepared to hear a most able lecture from a gentleman of his great reputation, I must say that I was not prepared for the comprehensiveness, the ability and research which this lecture embodies. We farmers can agree in a great deal that has been said by the gallant lecturer. I am sorry that circumstances did not allow me to take notes, as I would gladly have followed the lecturer throughout his lecture. I venture to think he has scarcely given sufficient importance to two points. Firstly, there are great numbers of horses retained in this country for the purposes of luxury. These horses in case of war are all available. And in a military point of view we must not forget the steam-horse, because, you know, our friends the Prussians at Paris had the steam-horse, which they found exceedingly useful. I have no doubt from all I see of steam traction and cultivation, that we shall see the steam-horse day by day more and more employed. I have watched him, not from his earliest infancy, but for the last eight or nine years, and I see him making wonderful progress. As regards the inducements to farmers to breed horses, by reason of the Government supplying stallions throughout the country, really as far as agriculture is concerned, we have many stallions, and really good ones. I doubt whether the Government offer would be a great inducement. As to purchases by middle men, I incline to agree in thinking it would be an advantage if Government were to go more into the market and buy for themselves. Referring to the lecturer's observations as to the use of cart horses for guns of position and military train purposes, I entirely agree with him. I know from my own experience that the thoroughbred cart horse is a better animal than the coach-horsy cart horse. The real cart horse keeps his condition better on the same food, throwing his weight also into the collar. I believe the Clydesdale to be the most valuable cart horse that we have. I have heard the origin of the Clydesdale horse was this:—A Duke of Hamilton, about 200 years ago, brought over a number of Flanders mares for his carriage; they were crossed with the horses of the district. I do not know at what period the Suffolk Punches were first bred, but I have no doubt that they have a Flanders origin. On the whole, and regarding our subject generally, I am inclined to think that we must rely for our supply of military horses upon the general law of supply and demand. But we must always remember there is a certain Chancellor of the Exchequer who knows all about the horses of the country; and whoever may be Chancellor of the Exchequer, he invariably lays a heavy hand on the horses, and thereby to some extent discourages horse keeping and horse breeding. Why, a man for a consideration dare not give another a lift on the road, for he does not know whether the stranger may or may not be a tax-gatherer. In conclusion, I would say again—the object of my speech—that the Royal Agricultural Society of England took this matter up. Some time ago, I myself got the principal veterinary surgeon of the Army to write a paper on the supply of horses for the Army, which paper was published in our Journal, and when in print we shall be glad to study Captain Hozier's able lecture, and to give it our best consideration. We civilians thank you for this opportunity of stating our opinions, and to the gallant lecturer our warmest acknowledgments are justly due and heartily accorded.

The Chairman: I think we are very much indebted to Captain Hozier for the able lecture he has given us, on a subject which is very important, not only to military men, but to the whole country, because England has from time immemorial been celebrated for horses and for riders, and I should think there are very few in this country who would wish her to lose her name for having the best horses and best riders in the world. I am afraid our class of horses are depreciating very much. For a very long time the mares have been going out of this country, and there has been an increased difficulty every year in procuring horses for military purposes, and for every other purpose, too. The difference of price tests the number of horses there are in the country. Just before the Crimean war, the horse artillery used to give thirty guineas for their horses, and the cavalry twenty-five guineas. Now the horse artillery give forty-five guineas, and the cavalry forty guineas. The artillery certainly are supposed to have four years old, and the cavalry also are supposed to have four years old; but they take them as four years old on the 1st of October, which is really three-and-a-half years old; so that there is very little difference there. During the last two years the General Omnibus Company have increased the price they give for their horses by £10. The price of the different horses employed on the tramways, in omnibuses, and railway vans has risen to an enormous extent, so much so that cart horses in a great part of the country are fetching £100 a piece. It seems an enormous price for a cart horse, but the price can be got as easily as possible now. We expect to get draught horses for our artillery and for draught purposes at the autumn manœuvres with the greatest facility, we imagine that we are to send out an order for two thousand horses, and we shall get them directly, but you cannot do that if you allow the mares to go out of this country. In a country like ours it is very important to keep up the breed of horses, not only for military, but for every other purpose, from racing and fox hunting down to *polo*, or any amusement you like to employ them at. I will not say, "down to *polo*," because I think it is a good game to teach young men how to ride; it is only on ponies; and the game is not very well known, but still it is a very good game. I do not quite agree with Captain Hozier on one point. He says he does not think it is necessary to consider the cause of the mares going out of the country. I do, because I think that is the cause of the whole evil. The cause of mares going out of this country is, simply, as far as I understand it, that there is not encouragement enough given to farmers to keep these mares. You must trust to your farmers. I do not believe that any breeding stud in the world will supply us with the number of horses that we want in this country. You want the farmers to supply you with horses, and for that they must keep their mares. Now what happens? In the last twenty years the coaches have been given up. The farmer has not been able to sell a horse he did not want to the nearest coach for a leader or wheel horse, or for any of those employments that were open to them then. The only chance they have of selling horses for light employments is to omnibus proprietors in connection with the nearest railway station. Then the question for the farmer is, "Which pays me most; a horse or a bullock?" I have been farming for some time now in a small way, although my military duties have taken me away so much that I could not attend to it properly (I live in Scotland); but I know that a horse does not always give you a profit. Therefore, a farmer, unless he is encouraged, will not keep a horse. Now, the only plan which has ever seemed to me practicable in the way of encouraging farmers to keep horses, is to do away with the Queen's plates that are given for racing, and to employ the money as prizes at agricultural shows in each county. The Queen's plates are now useless as an encouragement to improve the breed of race-horses, because it is not the best class of animals that compete for these cups. Let a prize be given for the best stallion, which shall remain in the county or district (whichever the Government, or those whom they employ, shall think best), and cover the mares of the farmers who belong to the county club or association, at the small fee of two guineas, and something for the groom; the stallion not to be allowed to go out of the county or district on any consideration for that year. If you give this money in prizes, there is a chance of people being induced to bring the best stallions into the county. We have got plenty of good stallions in the country; they go to agricultural shows, they win a prize, but they are bought by the foreigner, and they go abroad. If Government could give such prizes as I have indicated, it would make it worth while to people to bring their stallions to the shows, on the condition that they should serve the mares of the farmers during the year, and they might have a testimonial, or whatever you choose to call it, to say that the horse has won a Government prize. I believe this plan would be a great encouragement to farmers to keep their mares; and persons who, perhaps, are not farmers, people in a small way, who have got a mare which they use for their own dog cart, would take their mares to the stallion to be covered; they would not only know that they were going to a horse that had won a prize, but a horse that had got the Government mark upon it, or the proof that it had won a Government prize. I believe if that were done you might give sufficient encouragement to farmers to keep their mares in the county and to breed horses. I do not believe in Government studs. A Government stud might provide a few stallions to travel about, but it could not possibly provide mares or horses, the expense would be too great. With the cups that are given for racing purposes, I believe you might cover the whole expense. At all events, this is the idea that I have formed on the subject, and I believe it to be the only practicable course. I think we ought to have the best horses in the world. Foreign nations have been sending over here trying to get the best blood out of the country. But I do not believe that any country can compete with us, because they have not got the feeding. The very soil makes as much difference in the production of horses as it does in the production of crops. You know perfectly well that you cannot get the same crop in every ground, and you cannot get the same horse on every ground. We have proved in Yorkshire, in Lincolnshire, and in Ireland, that the soils there suit horses, and there are other parts of England as well; but it is chiefly in those districts that you can breed horses. There is no other country in the world that can breed horses in the same way. Climate and soil have as much to do with the breeding of horses as with other things, including, of course, care and management. I beg to thank Captain Hozier again for bringing this important subject before us.

Colonel Baker, 10th Hussars: I am sure we all owe our best thanks to Captain Hozier for the very able, impartial, and accurate way in which he has brought this subject before the meeting. It is one of the greatest possible importance to every branch of the service, and it is one also which is open to very great controversy. I think that in dealing with it, we should first consider how the evil which Captain Hozier has placed before us has arisen, and next how that evil may be best met. I think it would be found on inquiry that it has arisen from three causes. First, from the increase of riches in this country, which has created a greater demand for horses; secondly, by the exportation of a very large number of horses to meet the demands of foreign countries, and those demands have been very great of late years. That evil has been very much increased by the exportation of a very large number of mares, in larger proportion than the number of horses. Thirdly, by what has been so well put before us by the gallant Chairman, the fact that it pays farmers better now to breed cattle—the price of cattle having so enormously increased of late years—than it does to breed horses. It remains for us to consider how this evil can be met. I must say I am very glad that Captain Hozier in his lecture to-night touched so ably, not only upon the question of the breeding of horses, but upon the question of a reserve of horses for military purposes, for upon that question of a reserve lies the main point with which we, as soldiers, have principally to deal. With regard to the breeding of horses, I think we must give up as hopeless the idea of providing for the deficiency by means of Government studs. But there is no doubt that immense encouragement might be given to breeding by the means which have been laid before us by the gallant Chairman, and by other means which have been considered, and which probably will be laid before us hereafter. But with regard to the question of a reserve of horses for military purposes, we can consider that question without reference to the executive or the Government. It appears, as it must appear to any one who has gone into this question statistically, that the number of horses in this country is at present quite sufficient for any military requirements that would be likely to arise. But we have no control over the horses of this country. Captain Hozier has given you the statistics, and the difficulties which occurred last year when we attempted to put a small *corps d'armée* (or what would be considered abroad a small *corps d'armée*) into the field. I have had long conversations with different dealers and different breeders relative to this question, and they all agree that it would be impossible, even in cases of emergency, to provide anything like a sufficient number of horses to put a very small force into the field. I have asked a great many opinions from a great many dealers and breeders, and they all say that there is only one means by which that can be done, that is by a system of requisition. That is very unsatisfactory. With that difficulty staring us in the face, I think we owe Captain Hozier very great thanks for bringing the subject forward in this way, and so opening up a discussion which cannot fail to be useful. Having said so much, I will now touch upon the point how we may make the supply of horses which does exist, useful for military purposes. Supposing we give, as it has been advocated, every encouragement to breeders, why should we not have all the horses in the country registered? They should be registered as it is, because they are taxed. Why should we not have them registered and described? And if the country is not prepared for conscription or ballot, as regards the supply of men, still I think it ought to be prepared for the ballot or conscriptive system as regards horses whenever the actual emergency arose. If we had all the horses registered, and had the ballot amongst those horses which would be required for the different purposes of war, and if those horses, having been examined by proper veterinary authorities, remain so registered, then in case of war we should know exactly in each county where to put our hands upon the number of horses that we might require. If those horses so registered were exempted from taxation, it would be a slight boon to those who would have to give them up, but only to give them up at a fixed price in case of war. I need not say that the horses in this country vary very much in price. Horses of extreme value might be drawn by this conscriptive system or ballot, but as the country would not be prepared to pay for horses of that description in case of war, they would come out of the category of horses for military purposes. Therefore, we should only draw and keep on the register such horses as the country would be prepared to pay a certain price for, in case the emergency arose. I trust that the subject will not be dropped, but will lead to a discussion that will be of value.

Mr. T. Pain: I should like to say a word if I am not out of order. I imagine that this question is one of pounds, shillings, and pence from beginning to end. The noble lord who spoke after Captain Hozier, said it was a subject that the Royal Agricultural Society had taken up very deeply. I quite agree with his lordship that we have taken a great deal of interest in it, but we have been unable to arrive at any conclusion whatever upon the subject. I heard the gallant gentleman who has just sat down say, that it would be an excellent thing to have a sort of registration of the number of horses that were kept in this country, so that in case of war they should be called upon to be useful to the service. But I take it if any gentleman was in possession of a horse worth three or four hundred guineas, he would think it very hard that he should be called upon to give up that horse. (Colonel Baker: I exclude them). But, then, the poor man who has got a horse of thirty-five guineas value would say that it was very hard that he should have to give up his horse, and the rich man be allowed to keep his. All these things I contend are a matter of pounds, shillings, and pence. One or two remarks have been made as to the breeding of horses. The gallant Chairman says it would be an excellent thing if we were to do away with the Queen's plates, and to have horses in the different counties which should be available for the service of farmers at one or two guineas a-head. That is a very good idea as to placing of stallions. Then there is another to follow afterwards. A farmer says, "I can go and use this horse at one or two guineas; I have a very good mare, and I shall put her to it." But he sits down over his churchwarden's pipe, and he begins to calculate the odds, and he arrives at this conclusion—"If I put my old mare to this horse at one or two guineas, when the foal arrives at the age of three years I may be unable to get twenty-five or thirty guineas for the horse. I have got a cow, I can put my cow to the bull, and in twelve month's time I can get a heifer that may be sold for seventeen or eighteen guineas." Now, the price of cattle has so much increased in the last eight or ten years that the farmer naturally feels that he must farm that which is most productive to him. (The Chairman: I did not say that the colt was to go to the Government. Let the farmer make what he likes out of it). Nor did I. His price as a three year old may be worth thirty-five guineas, but the farmer has got to get a customer for it. Then the colt may have the strangles, he may be a roarer, or he may become blind. But the heifer will be worth sixeeen or seventeen guineas in twelve months. A noble lord said to me the other day, "Pain, what can I do for the purpose of increasing the breed of horses? I should like to buy a stallion, and I should like to buy half-a-dozen good old-fashioned mares, that I would give to my farmers to induce them to breed." I said, "My lord, you may get the mares and you may get the stallion, and they will breed, perhaps; but you must do something more, you must give them a guarantee that when the animal is three years' old you will give him £35 for it, whatever it is. Then he will be induced to breed, but unless there is a certainty about it he will not breed horses, but he will breed a cow." You may endeavour to lay down theories as to the breeding of animals of any description, but it only comes to one thing, that is £ *s.* *d.* All these theories may be very good, but they are of no use when they are brought into practical work. I have one idea about the subject, a very poor one; it is this, that a stallion should be put into every county, that stallion to be the property of the Government; that that stallion should not be allowed to be put to any mare that has not hereditary soundness, and that Government should offer prizes to the amount of £50, not for stallions, but for the best three and two-year old foals bred from this mare. Then you will induce the farmers to breed, but you will not induce them to breed unless you can show that there is the prospect of certainty.

General Sir William Codrington: I should doubt very much whether the increase of price shows a scarcity of horses in the country. In every single thing in this country prices have risen, and unless the lecturer will be able to show that there are fewer horses at this moment in England than there were before the price was raised, I do not think the question of price tallies with his argument. As everything has risen in price, so Government may have to give more, as every gentleman has to give more for the horse that he wants to ride. Artillery horses are no exception, cavalry horses need be no exception to this result, therefore I should be glad to know if there is really any such scarcity, independent of the price as a test. I do not quite think price is a test of scarcity, because everything has risen. There is no doubt the whole question is one of pounds, shillings, and pence. If Government would choose to raise its price to fifty, sixty, seventy, or one hundred guineas, the Government would get the horse they wanted; there cannot be a doubt of that, for horses can be got by gentlemen who want to hunt, or by those who want to ride them as hacks. I believe the horses would come if the money was forthcoming. I do not say Government can afford to give those great prices, but horses can be had by paying for them, for, as I said before, it is quite a question of pounds, shillings, and pence. With regard to the registration of horses, there would be great difficulty with respect to it in a country like England. We should have to provide a large civil establishment for the purpose, and we know that civil establishments, interfering with the liberty of private arrangements, are not well looked upon in this country. I rather doubt the practicability of carrying out the proposal in England. You may be quite sure that if ever this country should want horses for military service, in case of invasion,—which it now seems is the main purpose for which an army is to be maintained,—it will not be a question whether you shall buy, you must have a temporary dictatorship with power to take horses when and where it is necessary.

Mr. PAIN : You must bear in mind that the value of the horse has very much increased of late. Horses are now, I should think, 33 per cent. dearer than they were four or five years ago. But there is this to be considered, that the wealth of the country is so much greater than it was, that more people keep horses, more men hunt, there is more luxury at the present moment than there has been for many years past. One observation which the noble lord made was of a practical character; it was this, that if you took off the tax upon horses, it would conduce to the improvement of the breed of horses, by enabling people to keep horses; you might as well tax a cow as tax a horse.

Sir W. CODRINGTON : To make another remark. The lecturer, Colonel Baker, and myself were at the establishment at Trakehnen, in one of the provinces of Prussia. Perhaps the lecturer will describe to what distance that establishment extended its ramifications in the provinces, whether the large establishment we saw there was merely for keeping a centralised establishment, or whether the stallions were sent round the different parts of the country. My impression is that they were so sent to cover mares in the different parts of the large province in which the establishment was situated. They leave the stock with the farmers, and I think the Government take them at their own price in consideration of the stallions being sent out free. If the lecturer could give us some explanation on that point it might be interesting to the meeting.

Earl CATHCART : There is one point of considerable importance which I omitted. I have read an admirable paper somewhere, I think it was in the *Révue des Deux Mondes*, on the recent use of railways in war. It was especially laid down by the Prussians that a railway in war in advancing an army, comparatively could be little depended upon. One objection was that it deteriorated the troops, that infantry carried by railway did not come up in such good fighting condition as those marched by road. Another objection was the want of expansibility. You want troops coming to the front to expand fan-like. I entirely agree with my friend (Mr. Pain) that the breeding of horses, as I said before, like most things in this country, depends upon the general law of supply and demand, or, as he puts it very tersely, on £ *s. d.*

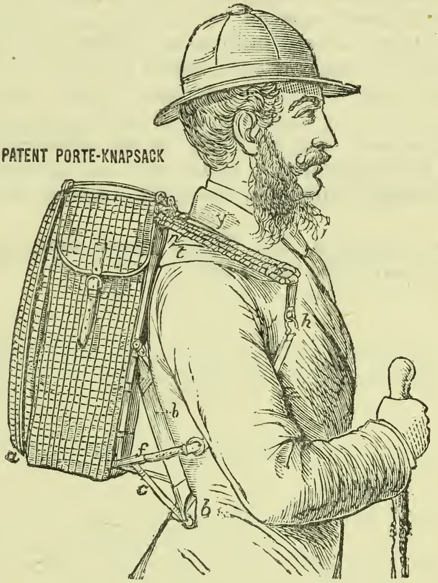
Captain HOZIER : I believe Sir William Codrington is perfectly accurate with regard to the Prussian stud at Trakehnen. The stallions are sent round to the farmers in the province, and Government have a right to take the stock at a certain age and at a certain price. But I believe the Government stud at Trakehnen, as far as the horses actually within the walls are concerned, are not intended for military purposes, they are kept chiefly as sires to serve mares all through Germany. As to the question of a diminution of horses in this country, I am not prepared without book to give an opinion about that. I rather think the Board of Trade returns show that the supply of horses has actually diminished in this country to a small extent. If I remember right, within the last three or four years, this diminution seems to be at the rate of two or three hundred a year, whereas the number of horses ought to increase with the increase of population and wealth. (Sir W. CODRINGTON : That is the taxed horses ?) I believe the returns are made of all horses. The thoroughbred horses have also decreased in numbers within the last two or three years. I believe the thoroughbred stock has considerably declined during the last two or three years. There is only one word more that I wish to say. The noble earl spoke about the use of the steam-horse in war. I hope he does not think we do not attend to that in our army, because we have had a traction-engine at Aldershot, and we find, as the Prussians have found, that it is very useful when an army has settled down for a siege; you can then use the traction-engine. But as long as an army is moving across country, over mountains, and where roads have been broken up and bridges destroyed by the enemy, then, for all practical purposes a traction-engine is useless.

Besides that, the traction-engine requires an enormous quantity of fuel to feed it, and it would be necessary to have almost as much transport for the engine as for its load.

The Chairman: We have to thank Captain Hozier for his valuable paper, and also the gentlemen who have favoured us with their observations.

Mr. William White, F.S.A., of 30a, Wimpole Street, exhibited and explained his Porte-Knapsack as follows:—

The Knapsack itself is like an ordinary waterpoof one, but is fitted with light stiffening canes, to allow of contraction in size, and of simplicity in the fastening of it.



PATENT PORTE-KNAPSACK

The Porte-Knapsack has a very light frame, or yoke (*y*), to keep the bearing webs in *tension.* The whole of *the weight*, instead of dragging as usual from the *front* of the shoulders, *is carried upon the shoulders by these tension webs* (*t*), except what is distributed on to the back, by the back webs (*b*) resting gently against it. The webs should be buckled just tight enough, to keep the cane yoke (*y*), and the cross cane struts (*c*), at about the angle shown on sketch, when in use. If not tight enough, the Knapsack will have a tendency to slip off, if too tight, it will not fit pleasantly. The proper adjustment is when it will just lodge on the shoulders and back, without the aid of the fastening straps (*f*), which are required to keep the load from jolting off, but which still allow perfect freedom from strain and leverage. These fasteners, fitted with the usual hook and eye (*h*), should be buckled as short as they will go, without being tight enough to *press* against the front of the shoulder. When not in use, the shoulder yoke and the cane cross struts may be kept folded close on to the back of the Knapsack, by passing these fasteners behind the tension webs and hooking them into each other. The small neck strap (*n*) should be tight enough only to keep the back of the cane yoke well off the neck of the wearer.

I have carried with the Knapsack over 20 lbs. weight without inconvenience, and I have carried, at the rate of more than four miles an hour, 15 lbs. with less strain than I could have carried 10 lbs. at a slower pace by the old mode.

Rejoicing as I have always done in the freedom and independence of Knapsack excursions, though fain to seek relief sometimes from the labour, and the langour, entailed by all previous methods of slinging the burden, through which multitudes of soldiers, especially young soldiers, as well as civilians, have suffered terribly, it is a pleasure to place within the reach of my friends (and of the public generally) a mode by which it may be carried without such inconvenience.

The Porte-Knapsack may be fitted to an ordinary Knapsack; but the expanding Knapsack which forms part of the same patent, and which is particularly simple in its arrangements, is specially suited to it.

In reply to a question, Mr. White stated that the weight of the apparatus was about 2 lbs. and a-half.

Evening Meeting.

Monday, July 8th, 1872.

Captain JASPER SELWYN, R.N., in the Chair.

NAMES OF MEMBERS who joined the Institution between the 2nd and 8th July, 1872.

LIFE.

Gordon, W. E. A., C.B., Captain R.N.
Hart, Horatio H., Lieut. R.E.
Fitzherbert, W. H. M., Lieut. Rifle Brigade.
Kenyon-Slaney, Walter R., Lieut. Rifle Brigade.

ANNUAL.

Elliot, A. F., M.D., Staff-Surgeon.

READ AND NICKOLL'S PATENT INDICATING DAY AND NIGHT HELM SIGNALS FOR PREVENTING COLLISIONS AT SEA.

By Mr. George Read, R.N.

I have the honour to bring before you this evening an invention for the prevention of "Collisions at Sea."

It is a subject which must enlist the attention and sympathy of every class of the community, whether it be the shipowner, the ship insurer, the merchant, the traveller, and last but not least, "poor Jack" himself, as all have a vital interest in this most important question.

The traffic on the ocean has become so great, the value of the merchandise so immense, the sailors employed, and the public who travel by sea so numerous, that every nation is not only interested, but is in duty bound to adopt such measures as may tend to lessen the loss of life and property by those fearful collisions, which are continually occurring, and to render voyages as free from danger as possible.

In order to convey an idea of the magnitude of the subject, I beg to call your attention to the last published returns of the Board of Trade, by which it will be seen that the total number of British vessels entered inwards in 1866, amounted to 33,393, equal to 10,692,102 tons; and in 1870, to 35,182, equal to 12,380,390 tons, showing an increase of 1,789 vessels, and an increase of 1,688,288 tons.

During the same years there were cleared outwards, viz., in 1866, 32,203 vessels equal to 10,563,624 tons, and in 1870, 35,405 vessels, equal to 12,691,790 tons, showing an increase of 3,202 vessels, and of 2,128,166 tons; so that in four years, viz., from 1866 to 1870, there was an increase of 4,991 vessels, equal to 3,816,454 tons.

With regard to foreign vessels there were cleared outwards in 1866, 24,575, equal to 5,086,656 tons, and in 1870, 24,751, equal to 5,835,028 tons, showing an increase of 176 vessels, and an increase of 748,372 tons.

Thus the total number of vessels, both British and foreign, cleared outwards in 1870, was 60,156, the total number of tons amounting to 18,526,818.

To navigate and man these vessels, it may be estimated that there are not less than half a million of men employed. As the number and speed of the vessels increase, so unfortunately do collisions become more frequent.

I have made out an estimate of the loss of property by collisions, and it is something like one hundred millions per annum. Whilst in 1869 the collisions amounted to 2,185, of which 157 vessels were totally destroyed, in 1871 they amounted to 2,561, of which 176 were entirely lost.

That steamers are rapidly supplanting sailing vessels is shown by the Board of Trade returns. In 1870 the tonnage of steam vessels built in the United Kingdom was 225,665, and of sailing vessels 117,032; making a difference of 108,634 tons in favour of steam.

In a very able article in the "English Encyclopædia," on Collisions at Sea, written by the well-known Mr. Saxby, R.N., it says, referring to the question of lights, "and committees and others who have approached the question of Collisions at Sea, all seem to have neglected to give due prominence to the want of attention to that which is the *root of the evil*, namely, that when ships are approaching in opposite or oblique directions, no collision would be likely to take place, *if one Commander knew what the other was about to do with his helm,—positive safety hinges on this.*" Again, the same author says, "without the aid therefore of some further legislation, can we hope to prevent collisions. It may, however, be remarked, that if two persons are meeting carelessly on a pavement collision is only avoided by one of the two knowing in proper time what the other is about to do. The same remark applies to shipping; a ready means of knowing in time the intended motions of an opponent seems indispensable to safety."

The present system of lights has proved inadequate for the prevention of collisions.

Our invention, if adopted, would render collisions next to impossible; as it would supply the one thing needed, as mentioned by Mr. Saxby, viz., *enable one Commander to know what the other was about to do with his helm.*

It is true that the 13th article, of the "sailing rules," attempts to provide for the emergency of two ships meeting, but it often happens that other vessels are so much in the way, and in such positions that their regulation lights do not show, and for other reasons it is frequently impossible to obey this rule; it is thus left entirely to the judgment of the person in charge of the ship, which way he will put his helm, and should each vessel be steaming at the rate of 12 knots per hour, they would be actually rushing at each other at the rate of 24 knots an hour; there is thus no time to deliberate. A may imagine that B will put his helm to port, whilst B with equal justice may suppose that A will put his helm to starboard, the consequence is, that although each may have used his best judgment, for want of knowing with certainty, which way the other will steer, a collision ensues with probably great loss of life and property.

With the *side-lights* now in use, it is impossible at night to know when a vessel is approaching end-on, or nearly end-on, whether she sees you, and intends to alter her course, and, if she does, whether she will pass on the port or starboard side, hence arises, immediate danger to both vessels. It is often a source of anxiety to those in charge of a sailing vessel sailing by the wind "close hauled" "which side a steamer will pass, when she is coming on to the sailing vessel in a position abaft the beam where the regulation lights do not show to the steamer.

The adoption of our signals will not in any way interfere with the sailing rules or lights at present in use; it might almost be said they would not be additional lights, but simply, so to speak, a reflection of the existing ones, with the great additional advantage, that they would infallibly show, not only which way a ship is steering, but which way she is going to steer; in fact, reveal the mind of the person in charge of the ship.

There are other purposes to which these signals may be applied with great advantage, as for instance,—in piloting vessels into tidal harbours. The harbour-master could indicate the course a vessel coming into the harbour should steer, and at the same time, the vessel would show by the movement of her lights, whether she understood the directions, and is following them.

Again, in taking up a berth in a crowded roadstead or river, the "helm light" would show what sheer a vessel at anchor had; for example, a vessel's helm is lashed to port, the red light shows at once that is the position of the helm, and the cable will be leading on the port-bow; and if she is riding with starboard-helm, the light will be green, and the cable will be had from the starboard-bow, so that a ship coming in to anchor will know on which side to drop hers, and thus avoid taking up what is called a "foul berth."

I do not attempt to introduce a system that has not been fully tested. The "helm-signals" have already been exhibited and worked at sea in the presence of a Committee of Lloyds, and Lloyds' Salvage Association, and many other gentlemen, all of whom have expressed their entire approbation of them, and consider they should come into general use. I have also exhibited these signals at Liverpool with similar results, and particularly before the Mercantile Marine

Service Association. With your permission I will read two or three testimonials which I have received with many others. (See Appendix.) I may state that I have also had the honour of exhibiting our signals before Earl Granville, off Walmer Castle, from the "Palmerston" tug of Dover: she was sent out expressly in a gale of wind, in order that his Lordship should see the working of the lights at sea.

The apparatus (see Plate)* is so adjusted that it may be hoisted and lowered for the purpose of lighting or trimming the lamp, without the least trouble, thus avoiding the necessity for a man going aloft. It can be treated as the common steam-ship-light now in use, and is self-regulating, any cabin-boy can rig it, and being perforated at the back, the Officer of the watch can see which way the man at the wheel is steering, whether he is doing his duty, and obeying orders. He can also see whether the light is well trimmed and burning. If the man at the wheel should happen to fall asleep or to put the helm the wrong way, the officer of the watch can see it by looking up at the mast-head. At present it is impossible to know what the man is doing with the wheel except by standing at the wheel; you do not know whether he is giving one or two turns, but by looking at the indicator, which is very sensitive, it is impossible to mistake.

The whole apparatus is very inexpensive, and the mechanism so simple that it cannot get out of order.

This lanthorn, as you will perceive, is made in the form of an ordinary masthead lanthorn, with a circular burner at the back, which is surrounded by circular glass shades—one green shade, one blank, or metal shade, and one red shade; these shades are caused to move up and down (around the burner) by the movements communicated from the ship's helm. These shades also act as a chimney to the flame, and thereby consume the smoke and greatly increases the power of light.

The following are the advantages I claim for these signals:—Whilst they do not in any way alter the existing lights carried by sailing and steam-vessels, nor necessitate in any manner the alteration of the present sailing orders or "rule of the road at sea," they furnish an inexpensive and certain mode by which the course vessels are steering, or about to steer, is at once made manifest, and must consequently very greatly diminish the chances of collisions. They furnish a better method than the present by which vessels may be piloted by signals into tidal harbours, and they will also prevent vessels coming into crowded rivers and roadsteads, taking up foul berths.

Mr. Gray, of the Board of Trade, has in his Aids to Memory, made use of rhymes which he has got the sanction of the Admiralty to have printed in different languages, to set forth the rule of the road at sea. If Mr. Gray is right in theory, I certainly must be right in practice. He says,—

"Meeting steamers do not dread,
Port your helm and show the red,
Green to green, or red to red,
Perfect safety, go ahead!"

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* Models also may be seen at the Office, No. 6, East India Avenue, Leadenhall Street.

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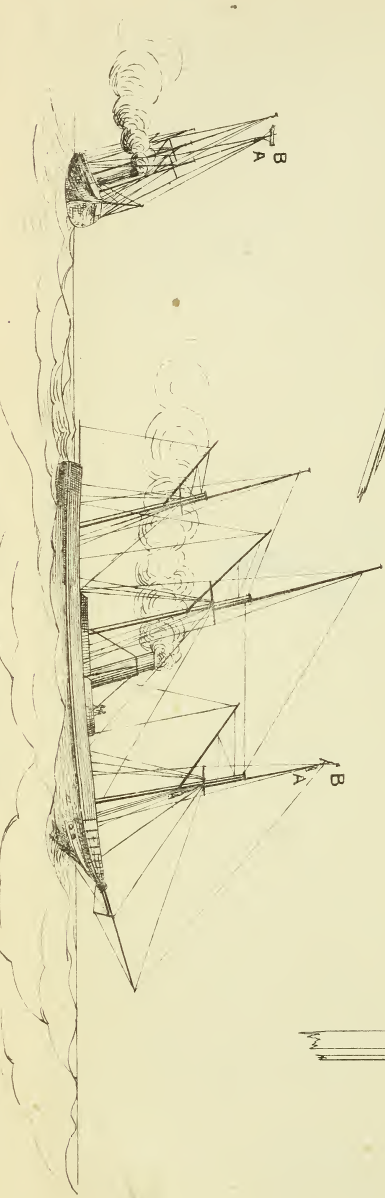
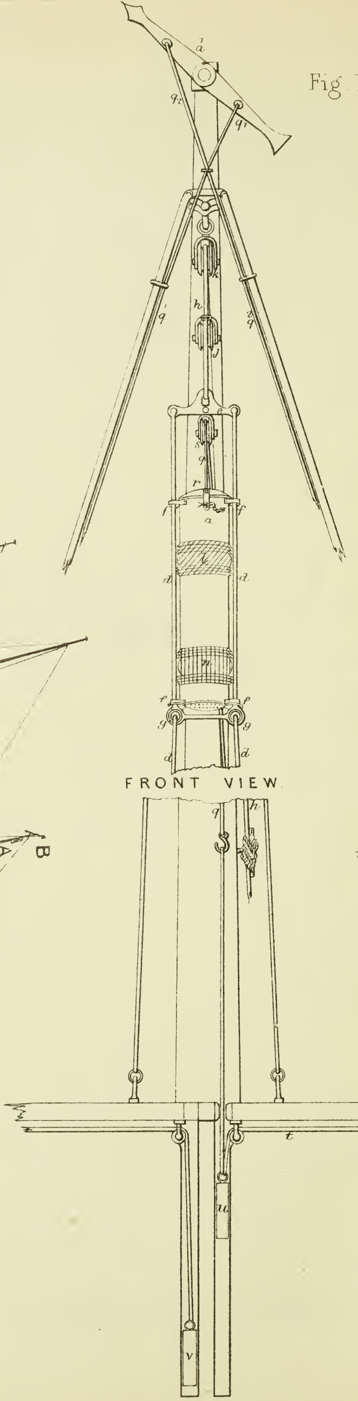


A. Lamp — B. Semaphore.

Fig. 1.



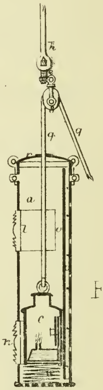


Fig 2.

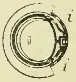


Fig. 3.

J. Jobbins.

And in his third verse,—

"If to your starboard red appear,
It is your duty to keep clear;
To act as judgment says is proper,
To port, or starboard, back, or stop her."

I say,—

"If you don't know which way he'll steer,
The indicator makes it clear.
For if the helm to starboard goes,
The green masthead-light clearly shows.
But, if he with a port-helm steers,
The red light then aloft appears."

I will now show you the appearance of a steamer with the regulation lights (exhibiting a diagram), and here is a steamer in the distance with a starboard-helm light. With our helm-light it would be clearly seen which way he intends to steer. He starboards his helm, and you see by the light that he is bearing away to go astern of your steamer. If he ported his helm you would know that he intended to cross your bows. But with the regulation light the great question is, "Which side will he pass?" You wait for him and he waits for you; hence one-half of the collisions. But as soon as you see his "helm-light," (I do not care whether there is a look-out or not) you know what he is going to do. The man on the look-out may say, "There's a ship on the starboard bow; with starboard helm." The reverse, if so, with "port helm." By our arrangement if the officer should give the order to port the helm, and looks up at the mast-head, he can see whether the steersman has done it. If the man puts the helm wrong, the officer is able to detect it in an instant. It would also prove to the approaching ship that you intend to obey the rule of the road at sea and port your helm, and, of course, he would port also. It would also prove in the Admiralty Court the position of the rudder when the collision took place. This is the appearance of a tug (showing a diagram), which is compelled by law to carry two mast-head lights. Where those two mast-head lights are carried by the tugs, I should carry ours. Our light is equally clear on a stay or a backstay, or on any other part where it is considered suitable. Here is a diagram of a ship in the Downs riding in a crowded roadstead. I am running into the Downs, and I want to get a clear berth to anchor. With our helm light above the anchor light, a ship seeking a berth would say, for instance, "There is a ship at anchor with port helm, and the cable is on the port bow, I shall have a clear berth if I get on her starboard side." The two anchors will be at the extreme on the turn of the tide. Since I have been stationed at Deal, I have seen many vessels collide through anchoring in what is called a foul berth; they cannot make out each other's position; the consequence is, they have to slip their anchors, or they collide and smash each other up.

I will now explain the semaphore. The semaphore is simply a yard (which need not cost more than a shilling or two), made of wood and slung as you see it; the two lines are simply brought to the wheel ropes of the tiller. If the ship steers with the wheel on the bridge, we have less gear. I propose to have a flexible wire rope, as wet or cold will not affect it. The semaphore would be of great use to steamships in the British Navy. I was cruising last summer, and saw a squadron, with the ships steaming one vessel after the other. It was difficult to know when a steamer was coming on behind at full speed, on which side she intended to pass. With this indicator there will be no doubt at all. We see the ship is porting her helm, and we know that she intends to come up on the right side. Reverse the semaphore, and it indicates that the ship is going to starboard her helm and to pass on the port side. Where the conformation of a river forms a bend, the hull of a vessel is often not seen at all; so the mast-head is the thing to look at; you see by the indicator that she has got starboard helm, and you know that she intends to go close round the point. The same with regard to lights at night. The present lights are deceptive. One vessel going down the river, and another vessel coming up, where the river forms a bend, the one shows the port light, and the other the starboard light; the consequence is that they cannot comply with the rule, without going right round each other's bows. With our light that difficulty is avoided. The light is slung in the ordinary way. It can be applied to the topmast stay or to the forestay clear of all square sails; and it can be lowered down. There is only one line to lower it down, and one line to trice it up.

I should tell you in conclusion that Lord Granville, who saw our plan tried, described it as "talking with the rudder;" and Mr. Gladstone, to whom I also had the honour of showing it, said that it was "the mute language of the rudder." He was much pleased with the illustration, which I had the honour of showing him, of our system. The great object I have in view is to save the lives of my fellow-creatures at sea.

APPENDIX.

From Sir Luke Smithett, late Manager, Royal Mail Packets, Dover.

I beg to state that I have, with several nautical and scientific gentlemen, carefully investigated Mr. Read's "HELM INDICATOR," as well as observed it when fitted on board a steam vessel for trial, and I am of opinion if generally known and applied to vessels at sea, many of the dangerous collisions which so frequently occur might be avoided.

The invention being simple, inexpensive, and easily applied, I can have no hesitation in recommending it to the shipping interest.

From J. A. W. Harper, Esq., the Secretary of Lloyds' Salvage Association.

Mr. Read has made an invention, which, after much consideration here, and *many experiments*, seems to those who have *conducted* and been *present* at the *experiments*, and have examined minutely the invention, very *complete*, and of *serious importance.*

The distinguishing points in this invention, are, that preserving the white light of a steamer unaltered, it presents two red lights when the ship has port helm, and two green lights when she has starboard helm, and that the changes in the lights are mechanically effected by a communication between the lights and the wheel itself, so that whenever the wheel is put to starboard, the green lights present themselves, and on the contrary, directly the wheel is put to port, the red lights show themselves.

And it will be seen that even changes in the direction of the ship, to port or to starboard, will be indicated by the shifting of the lights, because the lights vary mechanically with every movement of the wheel.

Considering how many collisions there are in the course of twelve months, I am sure that anything which gives a real chance for diminishing that number is something that deserves attentive consideration.

From the President of the Mercantile Marine Service Association, Liverpool.

On behalf of the Mercantile Marine Service Association, and as its President, I have much pleasure in conveying to you the unanimous approval of the Council, of your "HELM INDICATOR," for the prevention of collisions at sea.

After a careful inspection of your model, and also after, what is more important, *an actual experimental test* of the invention on board a steamer engaged for the purpose, during the day time, and after dark as well, the favourable impression your explanations have made upon the Board was fully confirmed.

It is their decided opinion that the invention is a most simple, and at the same time a most faithful and admirable contrivance for preventing collisions, more especially in the case of steamers.

I trust that this expression of approval by thoroughly practical men may be the means of furthering the adoption of the invention to the general benefit of the sea-going portion of this and other communities, and of the public at large in the probable saving of life and property.

From Mr. J. B. Millen, Cinque Port Pilot.

Your invention for the better protection of life and property at sea, is both ingenious in its design and very simple in its working, which, if adopted, especially amongst steam ships, would prove one of the best means ever introduced for the prevention of those fearful collisions we so frequently have now.

Steam ships, by adopting your invention, would confer a great boon on those navigating in sailing ships.

It is often a source of anxiety to those in charge of the latter, when a steam ship is approaching, to know the intent of those in command of those ships, especially in narrow waters, whereas your design at once reveals, I may say, the mind.

I have had many years' experience in navigating between Dungeness and Gravesend, therefore feel some confidence in giving you my opinion; I have often thought that some such invention as yours was much needed.

From thirty-one Deal Pilots.

We, the undersigned Trinity Cinque Port Pilots, having examined your "HELM INDICATOR," are unanimous in our opinion that it is the most efficient and practicable invention, in conjunction with the present system of lights ever brought before the public for the prevention of collisions at sea, as it is at once trifling in cost, simple in its working, and not easily liable to get out of order, and that it can be placed at the "fore stay," or any other convenient place when there is not sufficient room between the fore yard and the masthead light. We are sure that your invention must meet with the hearty approval of all practical men as *the one thing long needed*, for by the very movement of the *helm* you at once communicate your intentions to any approaching ship, which fact must materially reduce the risk of collisions.

We sincerely wish your invention the success it in our opinion so richly merits, and that we shall shortly see it added to the present system of lights.

From Rear Admiral Sir W. R. Mends, K.C.B., to Clarke Aspinall, Esq.

Mr. Read has suggested a plan for notifying to ships the position of the helm by day or night. The plan is, in my opinion, simple in design though clever in conception, and is certainly deserving of the best consideration; whether adopted for the high sea by Board of Trade or not, it would assuredly be of service in narrow waters.

Mr. BUTCHART, Trinity pilot: I should like to ask one question with reference to the semaphore. Would it have a green ball on the starboard side, and a red ball on the port tide?—(Mr. READ: Just so.)—It is used at night?

Mr. READ: No, the semaphore is not used at night. In the river you are crowded with barges, and I propose this (showing a cheap kind of semaphore) as a semaphore for bargemen. If they could not get a rod of iron, they could get a broomstick, and sling it in the middle, and connect it with the tiller in order to show which way they are steering. (Really a cabbage at one end, and a bunch of carrots at the other, would answer the purpose, and at the end of the voyage they might be eaten.) Many collisions take place in the day-time, and it is quite as necessary you should know what a man is going to do in the day-time with his rudder as in the night. With such an apparatus as this there is no excuse for him.

The CHAIRMAN: Will you show the new lamps, which I see on the table, in action? Which of the two sets do you propose to adopt?

Mr. READ: This one has been lately finished, and is not quite perfect. I will exhibit the difference of the two. This one, I should tell you, is made out of a common ship's lens; it was made by myself. I converted the side lenses, and put them into this cylinder. I show three colours by the motion of the rudder; white with the helm amidships, green to starboard, and red to port. It is a question to be decided hereafter, whether a vessel shall show a white light representing danger with the helm amidships. With white for the helm amidships, I do not interfere with the rule which Government have sanctioned, that a tug shall carry a white light for a second light. But as soon as ever the helm is shifted to starboard, it changes the colour to green; and when it is shifted to port you see the red light. This is simply a common mast-head light, but it shows with this lens the different colours. The regulation lights would not be interfered with in any way. If the Board of Trade should decide upon adopting our lights to register the movements of the rudder, then, I say, "here are your regulation lights, with the white light for steamers."

The CHAIRMAN: In the new lamp I see you have no light at all for helm amidships?

Mr. READ: No. There is already a bright light carried by steamers at the mast-head, so that with this "helm-indicator" you do not want another white light.

The CHAIRMAN: Is it not possible to make that take the place of the ordinary white mast-head light?

Mr. READ: We could do so by putting the white light in the centre. At present it is a blank; but it could be made to show white, as well as red and green by putting another burner in the centre. But that is a question of detail to be decided on hereafter. Some persons object to showing a white light with the helm amidships, so I would rather have it blank. The white light with the helm amidships shows that the vessel is steering a straight course, and is coming dead on you.

Mr. BUTCHART: Where do you propose to fix this light on sailing vessels? I can quite understand the principle on board a steamer, but with all sails set?

Mr. READ: I propose to put it on the topmast-stay, or on a stanchion that may come up under the foot of the foretopsail. But I can place it anywhere; I can place it on the topmast stay, or I can lower it down wherever you like. This is another apparatus made of copper, made by another lamp-maker. It is a very powerful lamp on a dark night, but it is a very expensive one.

A VISITOR: At what distance can that light be distinguished?

Mr. READ: The red can be seen from four to five miles off; the green would be seen about three or three and a quarter miles. It is not so powerful; you cannot see the green as well as the red.

The CHAIRMAN: In all cases it is about the same as with the ordinary side lights? It is a question of power of lights.

A VISITOR: What would be the cost of the mast-head light?

Mr. READ: With the other gear, it would be something like from £4 to £5.

The CHAIRMAN: But the expense of burning would be no greater than that of the present mast-head light?

Mr. READ: No.

Mr. HENWOOD: What would be the expense of the apparatus you propose?

Mr. READ: That would depend upon the vessel. If the ship was steered from the bridge, the drift would be shorter, and, consequently, there would be less expense. I should say, that the whole apparatus could not possibly cost more than £10 for the biggest vessel afloat. Wire rope is cheap, and can easily be put in tubes, and sunk in the deck, and covered over in the water ways. The friction is no more than that of the ordinary gear with blocks and tackles, on board ship.

A VISITOR: Then, when this lamp with the bright light for "helm amidships," is shown on board a sailing-vessel, how do you distinguish her from a steamer? The steamer at present shows a bright light?

Mr. READ: The question is, whether the steamer shall have a white light, with helm amidships, or whether the sailing-vessel shall be blank.

The VISITOR: But if I understand you correctly, yours is an addition to the mast-head light of the steamer. (Mr. READ: It is.) Then the mast-head light would always be there?

Mr. READ: It would always be there. I do not interfere with the regulation lights in any way whatever. Mine is a useful adjunct to the navigator in order to reveal to a ship under weigh the mind of the man who is steering an approaching ship. A steamer steaming steadily on would show two bright lights; but that is a question to be decided hereafter. I propose to show to the approaching ship the motion of the rudder by the aid of the lights and semaphore. I consider that, if this helm-light is used as a position light, with white showing right ahead, green starboard, red port, it would do away with side lights altogether.

A VISITOR: Could it be used for lighthouse purposes?

Mr. READ: Yes, or for dock-heads and light-ships on dangerous shoals. The light-keeper would say, "There is a vessel running along, I am sure she will be on the Goodwin." He sends up a rocket, and begins to show one of these indicators. The man in the vessel says, "There's the light-ship, he is drawing my attention: he is giving me a signal to starboard my helm. He knows I am running into danger, he can see it."

Mr. BUTCHART: The difficulty in that case would be this. Supposing there were two or three vessels running in the same direction, how would any one of them know that the light ship was signalling to him especially?

Mr. READ: I can only explain it in this way. The "Gull" light-ship the other night fired a gun and sent up two rockets, pointed in the direction in which the ship was on the Goodwin. The rocket is always sent in the direction of the ship. We can see it from the shore, five miles off, and can tell where a ship is on the Goodwin because a rocket is sent in that direction. The same thing could be done in this case, a rocket could be sent towards the ship for whom the signal was intended, and it could be seen as plainly as a light.

Mr. BUTCHART: I have a good deal of feeling in favour of the present regulation lights, as necessary for all the purposes that ordinary navigation requires, especially for rivers, and for any part in fact. You said that the officer in charge would know whether the man at the wheel was doing right. Now, on board steamers you have the man on the bridge, and the officer of the watch is always beside him; so he knows, without taking notice of the light, whether it is green or red. He has got the man under his eye, and he knows whether he is porting or starboarding his helm.

Mr. READ: Of course, if you are always watching the man at the wheel. But your attention cannot be directed to two things: you cannot be looking out ahead, and seeing what the man is doing at the same time.

Mr. BUTCHART: But it is most important in a dangerous navigation, to have your eye upon the wheel.

Mr. Read: They have more often to look out for danger astern, where there is no light to be seen at all, than they have ahead; because if one steamer is going five knots, and another is coming up at the rate of twelve knots, they have to look out astern to see which way that vessel is going to pass. The indicator would show whether she was going to port or starboard.

Mr. Butchart: I am a pilot, therefore, I presume, I know something of the matter. It is a subject in which I have for a long time taken a deep interest, and in which some years ago I had something to do in bringing about the present regulation lights. Before the establishment of these lights on sailing vessels, I saw the value of them: and my difficulty at that time was to know on what part of the ship to carry them. Experience has proved that to carry them either aft or forward is of little or no moment. The great thing is that the light shall be seen right ahead, and only in that direction, and two points abaft the beam. When two vessels are meeting each other, the law provides that both vessels shall port their helms and show their red lights. If both vessels are end on they see each other's lights distinctly. If you lose sight of the green and get full sight of the red, you know that the other vessel is porting her helm. That rule is very simple, and is generally easily acted upon. But with all this, collisions will no doubt occur, as they have occurred; as long as we have so much traffic at sea, long dark nights, foggy weather, gales of wind, and all the contingencies and changes of sea, there will be collisions, and all that can be said or done will not do away with them entirely. However, whatever will lessen the amount or probability of collisions, whatever means are adopted or aimed at to lessen collisions, is deserving of support and sympathy, and ought to be encouraged. But in the river Thames, for instance, there are difficulties not easily to be provided for. I am in the habit of taking vessels down from the docks to the Downs. The present rule is that vessels going down shall keep the right hand, and vessels coming up shall keep the other hand, that is, both vessels shall act on the port helm. But this is a rule that cannot be applied in the river in all cases; no rule can be rigidly applied. It seems rather paradoxical to say that if you acted upon a port helm in some parts of the river, and in certain states of the tide, you would be on the wrong side entirely. Above Gravesend, especially, these hard and fast rules will not do. If I go down in the day time or in the night time, and show my regulation lights, I think that is all that is required. I have great faith in the present system of lights, as to their sufficiency for nearly all the purposes of navigation. But suppose I am using the "helm-indicator," there may be two or three vessels ahead—which vessel is to know that I am telegraphing to her that I am going to port my helm? I may intend to port my helm to the vessel on my port bow; I may not be thinking about the other man at all, yet he may suppose that I am signalling to him, because both see the indicator. Another thing, you know we have got very large steamers to take down and bring up, and they require a great deal of care and good management to pilot them safely. We frequently have to port the helm, not to alter their course, but to keep them in their course. But your indicator would show that your helm is a-port, showing that your intention is to go clear of another vessel; whereas, the object is to keep the vessel straight and preserve her course. (Mr. Read: Then, he must put his wheel over.) Of course, he has got his wheel over. But, then, in the day-time the side of the vessel is a very important thing to keep in sight. If I have got a view of the starboard side of a vessel, and the pilot, or Officer in charge sees my starboard side, there is no difficulty in avoiding a collision. But the difficulty and danger is, if you, by your indicator show that you are altering your helm, without any intention of going near the other vessel, and which you are not intending to go near. Then, again, in the river there are very sharp bends; passing from one reach into another, sometimes involves an alteration of course to the extent of ten points. This is a very serious matter. Then, with porting the helm, or starboarding the helm, as the case may be, the pilot, or person in charge, is obliged to preserve the course of the river as much as possible without regard to right or left of a sailing ship. Then, we have so much traffic in the river, especially with sailing barges. The number of these craft is enormous. Since the repeal of the navigation laws, the traffic on the river has increased amazingly. In our days the difficulty lies with them, not so much with sailing vessels. We have to be guided a great deal by circumstances; we cannot abide by a hard and fast rule, and say, "I will keep on this side of the river and no "other." We cannot do that. I am obliged to port or starboard my helm without regard to any part of the river I may be in. Still, I said as before, there is a great deal of ingenuity about the scheme before us, and I should like to see it tested. I think it deserves the serious consideration of those who are interested in the question. It might answer in some parts, especially below Gravesend, or in the channel. Something was said about ships in tow of steamers. We know that according to the present regulation-lights a steamer towing a ship, is obliged to show two mast-head lights (8 or 10 feet apart) ; and as soon as we see the two mast-head lights, we know it is a steamer towing a ship. But if you are going to put a mast-head light on to sailing ships, according to the proposed plan, you will not be able to distinguish between a sailing vessel and a steamer. Then, something was said about guiding ships into harbours. I am not aware of any case where harbour-masters take any part in vessels entering a harbour of refuge. The pilot in charge is the person who is responsible ; he is the best judge of the course he ought to steer. The harbour-master standing on the pier-head cannot tell so well. But I do not see how the harbour-master can in any way indicate to a vessel how he ought to put his helm. Again, about the anchor-light, there is something important to know about that. There are only two roadsteads in which the anchor-light as proposed would be available ; that is the Downs and Yarmouth roads. In Portland, which is a large resort of shipping, it would be of no use at all, because ships always lie head to wind, for there is no run of tide at all. No doubt, when it is spring-tide in the Downs, and when the helm is an object, Mr. Read's suggestion is a very important one. But when it is neap-tide, and at other times, there is nothing for the helm to do ; the ship lies head to wind. However, it is an important suggestion, and it is worth considering whether it could not be carried out. I have often, in trying to find an anchorage in the Downs, to observe which way a vessel is lying in regard to her anchor, and then to place my anchor so as to clear her. At night-time it would be very important for pilots, and others, in charge of vessels to know where there was a clear berth. About the changing of green, red, and bright lights, alternately, as shown by plan, showing that the helm is oscillating between one point and another, you must remember that lights at a little distance always blend. You would not be able to make anything of that at all, at least not distinctly. You would find at a certain distance the two lights would blend ; you would not know whether it was red, green, or whatever colour it might be. I can only repeat that I am afraid the plan would not answer in the Thames. We have strong tides, and many things to contend with, which compel us to disregard these hard and fast rules, and to port or starboard as circumstances may dictate. However, it is a very ingenious plan, and the lecturer deserves very great credit. I hope it may succeed, and I think it may succeed in some places, and ought to have a fair trial.

A VISITOR : I am not a nautical man, but it appears to me that one or two of the last speaker's remarks cannot apply. He said, in the Thames he was obliged to put his helm hard-a-port in order to keep his course. (Mr. BUTCHART : No : I did not say that.) In order to keep his course, or that he was obliged to work against the current by porting his helm or starboarding his helm ; whereas the ship is not answering to it, but is simply keeping her course. I think it proves the use of the semaphore, because a vessel coming the other way would say, "It is nothing, he is doing all he can, he wont wash out against me, because I see his helm is ported," or the other way. With regard to the tidal harbour, it is perfectly true that the harbour-master cannot act. It very often happens that masters of vessels do not know the right tide at the harbour's mouth, so they often miss the entrance to the harbour ; and a vessel often meets her death in trying to save her life. There is no reason why the harbour master should not be entrusted with a duty of that kind ; or, in the case of a ship approaching the shore, why he should not guide it into the right path. With regard to the Thames, I know from experience that there are many currents in the Thames, but at the same time I should be disposed to contend that if I was working against the current by means of my helm, I am only showing to others what I wish them to know.

Another VISITOR : I am a young man and my experience is very slight, only about ten years on the river. For nearly a year I went a voyage up and down the river Thames every week. It used to be my delight to be on the bridge with the Captains of steamers going down the river at one o'clock in the morning. I know their great difficulty was this, they were always saying, "Where is that man coming to? what is he doing? how are we to tell which way he is steering, or where he is going to?" Simply because there was a barge or another ship hiding the red light on the port, or the green light on the starboard bow. Whereas, if there had been a light above, which was not hidden, showing which way that steamer was coming, there would be no fear of a collision. There is one case in which I know a man was drowned solely because the Captain of our steamer did not know that the steamer was coming in the way it was, and the man was knocked overboard. Although young to express an opinion, still I feel sure that a light like this proposed by Mr. Read is of very great importance.

The CHAIRMAN: I have great pleasure in recognizing the extremely clever way in which Mr. Read has put the whole subject before us. I think the meeting will agree with me that considering,—I presume,—he does not claim to be a highly mechanical man, we could not have had a clearer or plainer illustration of what his views are. As to the question which has been discussed, as to whether this be or be not of utility in all cases, I can only say that knowledge is always useful; that those who misuse it when they have got it are very much to blame; and that when one comes forward to enable us to acquire knowledge—for which we have long been seeking—for use more in the open sea than in narrow channels, that man deserves great praise and recognition. I think the Institution will bear me out in saying that Mr. Read has given us a most important addition to our knowledge upon the subject. I have been struck with the simple and cheap way in which the plan is carried out. I have seen many plans of this kind, but I have seen none which approaches it in simplicity or in action; nor have I seen any plan which produces so many effects. I hope the Meeting will allow me to thank Mr. Read for his very able lecture.

Description of Plate.—*a*, the signalling cylinder shown suspended to a fore stay and within which cylinder the lamp *c* is caused to slide up and down in unison with the motion of the rudder in the manner to be hereafter described; *d*, *d*, guide lines fixed at top to a cross piece *e*, and at bottom to the deck or other convenient point of attachment. On these guide lines the cylinder is steadied and supported by the eyes *f*, *f*, which, in the ordinary position of the cylinder, rest on the thimbles *g*, *g*, or other suitable supports fixed to the guide lines. The cylinder is hoisted into position and the guide lines tightened by means of a line *h*, one end of which is attached to the cross piece *e*, and the other rove through the pulley blocks *j*, *k*, being then carried down to the foot of the mast where it is made fast. The block *j*, is provided with a ring which allows it to be raised or lowered on the stay *b* at pleasure. In openings in the front part of the cylinder are inserted the lenses *l* and *n*; the upper *l* being, say green; and the lower one *n* red; the said lenses are of the usual segmental form, in order to allow the rays of light emanating from the lamp to be visible over the requisite arc, or if preferred, they may be made circular so as to show a light all round.

The lamp *c*, Figs. 2 and 3, is constructed as an ordinary ship's lamp, by preference circular in plan and provided with reflectors suited to the arc of the lenses. A guide groove *o*, formed in it receives a tongue or fillet *p*, fixed in the cylinder prevents the lamp turning therein; the holes for the admission of air into the cylinder to support combustion in the lamp may be conveniently formed in this fillet (which is shown hollow), other holes being cut in the back of the cylinder to admit air into the hollow fillet; by these means draughts of air in the cylinder or lamp may be avoided. The lamp is attached to a lanyard *q*, which passes up through the cover *r* of the cylinder over the pulley block *s*, fastened to the cross piece *e*, and down the mast to near the deck, where it is attached to a line connected with some convenient and suitable moving part of the steering apparatus. This line connected with the steering apparatus may be a single line such as *t*, attached at one end to, say, the tiller, as shown, and being led by guide pullies, preferably beneath the deck, into a suitable position, has at its other end a balance weight *u*.

The motion of the steering apparatus in moving the rudder to one side, will thus impart to the line *t*, a movement in one direction raising the weight *u*, and when the rudder is moved to the opposite side, the weight will draw the line in the opposite direction. The lamp lanyard *q* being attached to the said line or to the weight as shown will receive a corresponding movement; a weight *v*, may also be applied to the other side of the tiller to counterbalance the weight *u*. It will now be understood that the lines *q* and *t*, being connected together in such manner that when the helm is amidships the lamp *c* in the cylinder is suspended in the centre of the cylinder and shows no light, any movement of the helm to the starboard or port side will depress or elevate the lamp so as to bring it opposite to the green or red lens, and thus indicate at a distance from the ship whether she is steering a starboard, or port course, and when desired the position of the lamp in the cylinder may be indicated to the officer of the watch through holes *i*, *i*, in the back of the cylinder provided with coloured glasses corresponding to the lenses. The line *p* should be attached to that part of the steering gear that will move the lamp from the centre of the cylinder to one of the coloured lenses, before the rudder shall have altered the course of the ship to any material extent (or if preferred, it may be so regulated as to show the light only at the last turn of the steering wheel either way).

The relative positions of the lamp and lenses are not altered by the further movement of the rudder in the same direction, by reason in the one case, of the lamp coming into contact with the cover *r*, and raising the said cylinder thereby, and in the other case by the lamp resting on the spring *w*, or on the bottom of the cylinder, the lamp lanyard *q* becoming slack; by these means the lamp can never be moved beyond the lenses.

The cover *r* of the cylinder may be removed to admit the lamp, after which it is closed and fastened by thumbscrews or staples and wedge, as shown.

Instead of the single line or rope *t* and balance weight *u*, an endless line and leading pullies carried round the ship beneath the deck in any convenient manner and position, or rods and cranked levers or other suitable mechanism, may be employed to impart motion to the lamp; and it will be seen, that if preferred, the lamp may be made to remain stationary, and motion only given to the cylinder by similar means to those described for moving the lamp. If it is desired not to exhibit a white light when the helm is amidships, the white lens may be omitted and the cylinder left solid between the red and green lenses.

Figure 1 also shows a semaphore or yard arm, arranged and operated so as to indicate in the day-time the movements of the rudder; a^1 is the semaphore arm centred on a pin and placed in some conspicuous position in the fore part of the ship, as on the mast; q^1, q^2, lanyards attached one to each side of the centre thereof; these lanyards are led down and connected to endless line or to the weighted lines before described, in such manner that the motion of the rudder shall elevate as shown, that arm of the semaphore which corresponds to the side of the ship towards which the helm is put over, and thus indicate the direction she is taking or is about to take.

Instead of applying the before described light-apparatus at the masthead one such may be applied to each side of the ship, and being connected with the steering gear will indicate in a more efficient manner than the present regulation lights the position a ship's helm may be in at any moment, by so arranging the lenses, that the colour visible shall be that which accords with the side to which the helm is put over, and when so applying, the apparatus we prefer to use a masthead or position light the front of which shows white, and the starboard and port sides green and red respectively, for the purpose of indicating the general direction a ship may be taking.

By employing a suitable notation and code corresponding to the colours and positions of the lenses in the cylinder, any required messages or signals may be transmitted by the above apparatus, whether on land or sea; and for this purpose several cylinders and lamps may be employed with the lenses arranged and combined in any suitable manner, the lamp being moved in the cylinder by hand or by mechanical means, as may be preferred.

HILL'S BOAT LOWERING AND SELF-DETACHING APPARATUS.

By Edward J. Hill.

The apparatus consists mainly of two patent slip hooks (*b b*) of peculiar form, securely fixed to the ordinary chain slings at each end of the boat. These hooks engage with the rings (*c c*) attached to the lower tackle blocks by short lengths of chain. So long as any strain is upon the rings they cannot be detached from the hooks, but on the strain ceasing, by the boat becoming water-borne, they fall away from the hooks, and cannot by any possibility hook on again unless held by hand in the right position for doing so.

In order to prevent one fall detaching without the other, in the event of the boat becoming prematurely water-borne at one end only, a strong rope (*f f*), called the life-line, connects the two rings by means of the double hook links, or shackles (*d d*).

The life-line (with the lanyard (*g*) slicked out) is hooked in as soon as the boat is hoisted to the davits, and is then set up or shortened by the lanyard so as to draw the rings into an oblique position, as shown in Figs. 1 and 2. The effect of this is that a portion of the strain borne by one ring is transmitted to the other, so that neither ring is ever sufficiently relieved of strain to become detached until *both* are relieved. When the boat is *entirely* water-borne, and both rings relieved of strain, the latter detach themselves, and the boat is free. The life-line (which, while in place, is useful for the men to hold on to) falls into the boat; the rings, chains, and shackles remain suspended to the blocks.

In lowering a boat it is thus only necessary to slack out the falls until the boat reaches the water, *when it will detach itself and float away.* If one end reach the water before the other, or be lifted by a wave, it does not disengage, and may either be recovered to the ship by hauling in the least fall, or the other fall may be slacked out until the boat is entirely supported by the water, with the result before stated.

The only circumstance under which the rings may sometimes fail to detach themselves on the boat floating, is when the boat is very slowly lowered while the ship has much way upon her *in perfectly smooth water*, in which case the boat is easily detached from the ship by one man canting the ring in the stern of the boat, by pulling the small cord fitted to the eye in the side of the ring. Immediately this is done the two rings are simultaneously released from the hooks, and the boat detached.

Another means by which the self-releasing shall be ensured under the above circumstance, is the adoption of a boat-rope as ordinarily fitted to take the towing strain of the falls. If the water is *not smooth* the motion of the waves will detach the boat, even if it is being towed (in the absence of a boat-rope) by the falls.

To raise a boat from the water the falls are lowered, and the rings

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DISENGAGING GEAR PROPOSED BY Mr. EDWARD J. HILL

Fig. 1

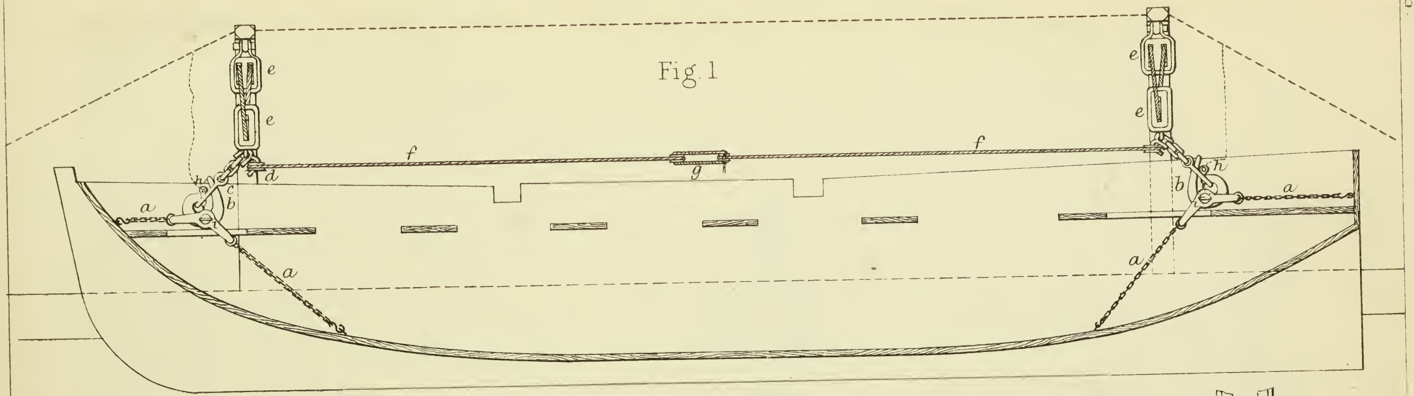


Fig 2

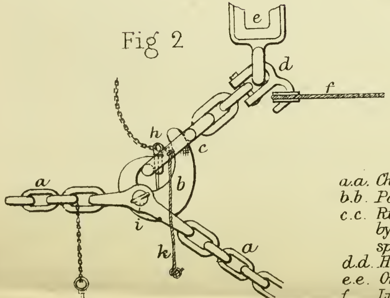


Fig. 4

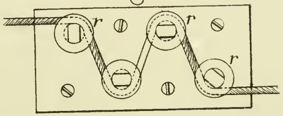


Fig 5

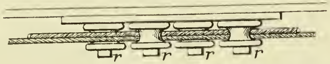
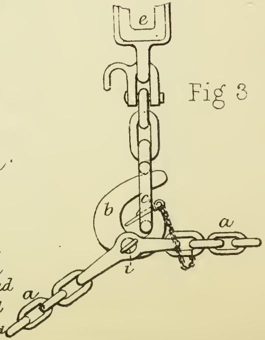


Fig 3



(Figs. 4 and 5) Rollers fixed on a plate inside the bulwarks over which it is proposed to pass both falls, to give greater controlling power over them in lowering, and to ensure their going out together, and the consequent descent of the boat on an even keel.

a.a. Chain Slings.
b.b. Patent slip hooks.
c.c. Rings (attached to the lower tackle blocks by short lengths of Chain) which disengage spontaneously when relieved of strain
d.d. Hook shackles.
e.e. Ordinary lower tackle blocks.
f Life line, preventing one end from detaching before the other
g. Lanyard for setting up life line.
h.h. Safety pins, secured by small chains to the davits or guys. These pins are self-drawn as the boat descends, and remain behind. When hooking on, preparatory to hoisting, other pins are used.
i.i. Rings to which ordy. steady. lines are attachd.
k. Lanyard for canting the ring c when required

passed over the hooks and attached in the manner shown in Fig. 3. The rings having been secured by safety pins, the boat is raised in the ordinary way, and the life-line is then drawn up as before explained.

When the boat is hauled up small, loose, safety pins (*h h*), attached by short chains to some part of the davits or guys, are substituted for the pins before referred to. The boat is then equally secure against being accidentally unhooked at the davits (as by a sea striking her, or in the process of turning inboard), while the pins *withdraw themselves* on the boat being lowered, thus preventing the possibility of mishap through the pins being unintentionally left in place.

It is claimed that the adoption of this invention will remove most of the risks incurred in lowering boats, either from swamping or from the detaching of one end before the other. It removes the necessity for leaving the detaching to the discretion of any of the men; an operation requiring great nicety and judgment in a heavy sea. It also tends to give confidence to the boat's crew, from the knowledge that the boat cannot be detached at either end until it has safely floated.

Mr. HENWOOD: Can you give some idea of the cost of your apparatus?

Mr. HILL: I cannot, as this is the first I have made, and I have not yet gone into it. I am not a sailor myself, but I wish those who are judges, to see my apparatus and ascertain its merits.

Mr. HENWOOD: I have fitted boats with both Clifford's and Kynaston's apparatus, and have objections to both of them. At present I do not see any objection to this plan, I think it is very good; and I think it is a matter which should be taken up by the Government, especially for the Royal Navy.

Lieutenant C. B. TEMPLER, late I.N.: There is one advantage that I see in Clifford's apparatus which I do not see in this, viz., that in lowering a boat in a sea-way to save life, the moment a sea strikes the boat, your tackle is disengaged, and she is left on the water, whereas by Clifford's apparatus the unreeving of the coil takes time, by which the man steering can steer clear of the ship.

Mr. HILL: I have always understood that Clifford's plan is not a slow one; he professes to be able to release the boat in fifteen seconds. (Lieutenant TEMPLER: The weight must be on the pennants to clear it.) It must depend upon the way in which the boat falls on the water. The boat lowered with my apparatus must in the first instance be in the proper direction of the ship, and if the boat then disengages itself the moment it touches the water, it would be in the best position in the world, because it would be parallel to the side of the ship.

Lieutenant TEMPLER: You cannot get clear of the lee of the ship; the lee of the ship would be pressing towards the boat, and that is the danger in a sea-way. Supposing it is a sailing ship, and a man is overboard (I presume the great object for which this apparatus for lowering boats has been devised is to save life), the ship must have a great deal of lee-way always, because you do not check her speed immediately, for very often the boat is lowered while the ship is going along; the ship would be going to leeward, and your boat would not be clear, she would be pressing under the counter, and would not get clear of the ship, whereas by Clifford's apparatus you drag the boat along to clear the pennants, and the coxswain puts the helm to starboard, and shoots her away from the ship, and the men can get their oars to work immediately. That is the only objection I see to the boat being lowered and disengaged so quickly.

Mr. HILL: It has always been my idea to get the boat clear of the ship as quickly as possible after it floats. It is the opinion of all sailors, that it is very important, in getting clear of the ship, not to have anything to unreeve after the boat is lowered.

The CHAIRMAN: I have the pleasure of saying on my own personal behalf that I have seen two inventions to-night (Mr. Read's Helm-signals and Mr. Hill's boat-lowering apparatus), which, as far as one can see from the explanations given, I approve of very heartily. I see that there is a great danger which is common to almost all forms of boat-lowering, with which I am very well acquainted with, both to Clifford's and Kynaston's, and to every other that has been used, and that is, there is very great danger of the will in the boat not being the will on board the ship. I have seen men, with all the different forms of lowering, get into trouble, constantly; first, because the lowering apparatus was not in order, and, in the second place, because the men did not work together. The question of towing alongside is one depending on the ship's way. Neither pennants nor falls will ever succeed in towing a boat so as to give her lee-way, unless the ship has head-way herself. I see no reason why the tackles in Mr. Hill's boat cannot be kept on at the will of the persons in the boat. If it were required to keep them on, then they could be stopped from releasing themselves. But I quite agree with Mr. Hill that the right way to lower a boat, and the safest way, is that the instant she touches the water, she should clear herself from the tackles, and that there should be no hooks of any kind whatever, and nothing connected with the ship which may catch any part of the boat afterwards. There is a second, and, I am sorry to say, a much more fertile source of evil, which is, that the rolling of the vessel very often brings the boat against the ship's side; this, if not very closely attended to, may stove the boat. In some of the modern apparatus we have an arrangement of guides, by which the boat is kept from being injured in that way. I think the only addition I could suggest to such an apparatus as this would be from the fact that some of our iron-clads are given to most sudden and unpleasant movements, and smash up their boats by that movement. It would be a good thing to attach to the boats some addition which would prevent striking against the ship's side. There will never be, by either this or any other plan, absolute security against the destruction of a boat, should the bow by accident come down first, so that a sea can get into it. If the boat happens to come down too soon, and gets a thorough good sea upon it while the vessel still has way through the water, the boat would be lost. But I presume Mr. Hill does not expect to do away with all dangers and all difficulties, but simply to diminish all those that at present exist, and in these circumstances I think he has been extremely successful in this model, as far as it goes.

MR. C. E. PARKER-RHODES ON "A MILITARY BOOT OF HIS INVENTION."*

Several years ago my attention was directed to the way in which all classes were subjected to much suffering arising from badly shaped, or imperfectly fitted boots, and particularly by the considerable discomfort experienced by the soldiery of every country. Notwithstanding the perfection to which the weapons of warfare have been brought, the soldiers' feet have been entirely overlooked, or else the problem of a boot suitable to all emergencies has not been fully considered by those who might have solved it long since to the comfort of the soldier and to the economy of the national budget.

The soldier should be equipped in barracks as on the battle field, for immediate action, and if our Volunteers are ever to co-operate with the Army, they, like the regulars, should be always thoroughly prepared, and yet what has occurred in the case of the Volunteers, might at any moment happen to the Army, as will be seen by the following, taken from Official Report:—

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* Read at an Evening Meeting on March 18th, Admiral the Earl of Lauderdale, K.C.B., in the Chair.

At the review of the Volunteers, at Dover in 1869, by H.R.H. the Duke of Cambridge, Commanding-in-Chief, in consequence of a flood of rain which had fallen, and had forced the whole of the troops to seek shelter, when the storm ceased, and the review commenced, it was found that hundreds of men were unable to rejoin their corps through the impossibility of getting on their boots, these having been taken off and placed before the fire to dry in a saturated condition.

The Volunteers having to purchase their own boots, and being in nowise restricted to pattern and quality, it would be supposed that under every emergency on the occasion of a review, when every arrangement is made to convey them to the very ground on which they are to manœuvre, the possibility of their being disabled by the condition of their boots could never have arisen.

In May, 1869, in the columns of *The Times*, the boots supplied to the Army, were made the subject of comments by Officers, and it was then shown that the soldier's boot is a cause of continuous suffering to him, even when engaged in the lightest military duty.

The Franco-German War of 1870–71, brought to light the inability of the French soldier to march as events required, solely by reason of the condition of the boots supplied him by contract after the declaration of war, and when he was already on the march to meet the enemy.

The fraudulent fulfilment of those boot contracts by the manufacturers is being investigated by the present Government of France.

I have lately received from H.M. Commissioners of Patents the preliminary protection for a system of manufacturing military boots which overcomes all the defects and evils of the various systems now manufactured.

My system combines these advantages:—

1. Guarantee of solid materials used;
2 That to make a pair of boots by hand, would not occupy beyond an hour;
3. That the boots could at any moment be suited to the ease and comfort of the wearer;
4. That no damp, or wet, could penetrate to the soles of the feet;
5. That the soldier could in barracks, or on march, replace the worn sole and heel;
6. That the inside of the boot could always be kept clean, thus avoiding the cause of foot sore and other infirmities arising always from the bad construction of the present systems;
7. That the cost of this system of boot-making per single pair, would be considerably less than the actual lowest contract price;
8. That with the exception of the wearing sole and heel, this system of boot is of permanent durability.

It is the only system that meets the requirements for all out-door duties.

Mr. Parker-Rhodes: To prove the facility with which my system of military boot can be manufactured, I have brought this rough model made entirely by myself. The materials of which it is made were easier for me to cut than leather.

A pair of boots for wear could be made by a practical hand in less than an hour. The cost would be considerably less than the actual price of any kind of boots as now manufactured; and their durability is unlimited, considering that the wearer can replace the worn sole and heel in a few minutes, wherever he may be, by having spare soles and surface heels supplied with each pair of boots; thus no inconvenience from uneven tread can arise.

The mode of fastening the boot enables the wearer to have a tight, or a loose fit according to comfort and ease for the foot.

When taken off, the entire length of the boot inside is laid open, and easily wiped out and dried, thereby ensuring a permanently clean boot.

The toe-cap or shield protects the whole front of the foot when walking over rough ground and against stubble, brambles, snags, or other obstructions, and against the entrance of wet or dust.

Admiral RYDER: The screw-heads would wear off?

Mr. PARKER-RHODES: They would only wear with the leather, and consequently would spread sufficiently to hold the sole firmly.

Admiral RYDER: To what extent is it used?

Mr. PARKER-RHODES: I have only just applied for Her Majesty's Letters Patent to bring the system under the notice of the War Office Authorities.

Captain BURGESS: Have you not shown your plan to the Emperor Napoleon?

Mr. PARKER-RHODES: I have the correspondence with me. I was invited to the Tuileries by the special desire of His Majesty, and explained the system, leaving a model of a boot made by me, and on the 16th March, 1869, the Duc de Bassano, H.M.'s Grand Chamberlain, wrote to me as follows: "His Majesty has directed me "to urge upon you to submit this model to his Excellency, the Minister for War, "when you have obtained your patent."

Captain BURGESS: Have you ever worn those boots?

Mr. PARKER-RHODES: Not yet. But on receiving provisional protection from H.M. Commissioners of Patents, I shall have some made for myself, confident of the superiority of the system over all present manufactures.

The Earl of LAUDERDALE: We are much obliged to you, Mr. Parker-Rhodes, for showing us the plan. I only hope the military authorities may approve of it.

Mr. PARKER-RHODES: It is a question of economy for the Treasury, as well as of permanent ease and comfort for the soldier. Having been closely connected with our merchant service in the discharge of my official duties in H.M. Consular Service, I consider the system would be a good one for our seamen.

The Earl of LAUDERDALE: For sailors the heel must not be so high.

Mr. PARKER-RHODES: The heel can be made suitable to the soldier and the seaman. I beg to thank your Lordship for this opportunity of exhibiting for the first time this simple invention.

The following extract from the final specification published by H.M. Commissioners of Patents, explanatory of the manufacture of his boot, and also a comparison of expenditure, are added at Mr. Parker-Rhodes' request:—

"This invention relates to the construction of a boot, shoe, or foot, "or foot and leg covering, which shall be capable of being at any "moment adjusted to the foot according to the requirements of the "comfort and ease of the wearer, and shall also prevent water or damp "penetrating to the soles of the feet, and shall likewise be capable of "being put on and taken off with great facility.

"To this end I construct the sole and heel in the following manner: "Between the inner and outer sole I insert an intermediate sole of "leather cloth, or such like waterproof material; I then secure a

“ wooden, or leather heel thereto, and face the same with a wearing surface of leather connecting the same to the wood (by screws by preference), as that method enables the wearer to replace this wearing surface as it gets worn away, I also prefer to screw on a clump sole for the same reasons.

“ The uppers I construct in the following manner:—I secure (by screws by preference) the upper made in one or more pieces, between the inner sole of leather cloth or such like waterproof material and the outer sole. I then add a vamp shield reaching above the instep of the foot or a toe cap, and screwed between the outer and clump soles. I then secure the inside of the upper over the outside, as also the vamp shield or toe-cap by means of eyes and buttons, through and partly around which a single lace is passed and fastened at the upper part.”

COMPARISON OF EXPENDITURE.

Present Regulation Boot.

		£.
	100,000 men, two pairs each per year, at 10*s*.	100,000
	Repairs per year, at 7*s*. per man	35,000
1.	Expenditure for boots for one year....................	135,000
	Or, for ten years	1,350,000
2.	Expenditure for gaiters, three pairs to each man, in ten years, at 5*s*..	75,000
		£1,425,000

The Military Boot.

Invented by Mr. C. E. Parker-Rhodes.

		£.
	100,000 men, one pair each for five years at 8*s*., or $\frac{1}{5}$th less	40,000
	Spare soles and heels..................................	10,000
		£50,000
3.	Expenditure for ten years................................	£100,000
4.	Saving in the War Office expenditure in ten years on every 100,000 men	£1,325,000

1. These repairs are now paid for by the soldier.
2. In some regiments each man receives one pair a year.
3. The soldier is provided for all kinds of weather.
4. This amount is far under the absolute saving to be made.

October 8th, 1872.

ON INFANTRY TACTICS.

Communicated by Lieutenant-Colonel W. J. Williams, R.A.

I. *Swarms of Skirmishers and Extended Supports.*

Some of our students of tactics now recommend to us swarms of skirmishers and ranks of opened-out files in support. No closed formation, it is said, can live under fire: we must attack and defend, especially we must attack, with swarms of skirmishers; and supports must be extended. These opinions seem to us to be zealous exaggerations. In their impatience of our old steady drill, and of our regulation of withdrawing skirmishers that we may have a steady line in front, some of our reformers are carried too far. They go with those German authors who have departed farthest from what is still the German regulation: we would rather hold with him who inspired the "retrospect of the retrospect." It was the German regulation which prevailed against the French army: the looser order of battle was tried only against the levies which France put into the field after her army was lost.

If we examine the theories of swarms of skirmishers and of opened-out supports, we find both theories wanting. Swarms of skirmishers is not a much safer formation for a given number of men under fire than formation in line; and opened-out supports must suffer as much as supports with closed files. It is difficult to fix the exact meaning of swarms of skirmishers; but we may fairly suppose that swarms of skirmishers would cover about the same front as would be covered by the same number of men in line. If the skirmishers were not equally distributed along their front, their loss, at that particular time, would be a little less than the loss of a line; but the tendency would be to an equal distribution along the front, and as the skirmishers should be more equally distributed they would suffer more loss. That the theory of opening out the files of supports to attain to greater safety is fallacious, becomes evident to us by the consideration that, in infantry fighting, supports are not aimed at. By the rain of fire passing over the skirmishers a company of 100 men in support would suffer equally, whether it were on a front of 40 paces or of 80, or of 120: each file would still be in the rain.

There is no doubt that the term "skirmisher-swarm," not swarms of skirmishers, gives a true picture of what the Germans saw when they looked at their first line in close battle. They saw that their first Line, with its reinforcements all in, had lost its organization of companies; and they saw that the men did not try to dress in ranks, but worked their way on here and there in groups. This disorder was properly named the "Skirmisher-swarm." We do not deny the power of the skirmisher-swarm. But we believe that swarms of skirmishers, sent out at first, would be wasted by fire until they were powerless. We allow that no regular formation can be maintained in the front line of battle. But we deny the necessity and the advisableness of adopting a loose array for our supports.

The true principle of modern infantry tactics is to expose few men to the fire of the enemy, until, the enemy being close to us, or we being close to the enemy, our strength is wanted. The object is to bring our strength close to the enemy. The issue must be decided, now as heretofore, by the threatening advance of superior numbers ready with the bayonet.

II. *Necessary Change in our Tactics.*

The new conditions of musketry fire necessitate one chief change in our infantry tactics. We must cease to close skirmishers on their supports and to assemble skirmishers on their reserve.

Our field exercise aims at securing to us the effective delivery of our musketry fire: little or no care has been taken to provide against unnecessary loss in our ranks from the fire of the enemy. The regulation gives us skirmishers in front of our line; but the skirmishers are to run away to the rear, when the enemy comes close to them, or when they come close to the enemy. At what distance from the enemy are our skirmishers to run away and leave our line bare? The flight of our skirmishers, near the enemy, would ruin the steadiness of our line, if it did not immediately cause disaster. If our skirmishers were to come back to us at any safe distance from the enemy, our line would be exposed to the fire of skirmishers, and we should suffer more loss than we should inflict. In either case, we could deliver no fire during the flight of our skirmishers whilst the fire of the enemy would not cease. We must never withdraw our skirmishers. Our skirmishers must be the first to meet the enemy. To make our skirmishers strong enough to meet the enemy, we must reinforce them. The skirmishers, reinforced by all that may be left of the battalion, must fight in a skirmisher-swarm, that is to say, in line without regard to organization of companies and without regard to dressing. We must not be disturbed by the sight of our skirmishers running away round our flanks to the rear: our minds should be filled with the idea of advancing.

III. *Order of Battle of a Brigade.*

A brigade should consist of three or of six battalions, because the normal order of battle of a brigade is three Lines of equal strength. We will suppose that a brigade consists of three battalions. A battalion should consist of eight companies. A company should consist of sixty files.

The normal order of battle of a brigade is three Lines of one battalion each. In the open, there should be a distance of 300 yards between the first and second and between the second and third Lines. In the open, and under fire, our first battalion would be exposed to unnecessary loss if the whole of it were placed in front from the commencement: we should therefore divide our first battalion on three lines. In the open, then, and under fire, our brigade would stand on five lines. In front would be the two flank companies of the first battalion; at 150 yards in their rear would be Nos. 2 and 7 companies of the same battalion, as supports; and at 150 yards in rear of the supports, the remaining companies of the battalion, in reserve. At 300 yards in rear of the reserve of the first Line would be the second battalion in second Line. At 300 yards in rear of the second Line would be the third battalion in third Line. The two flank companies of the first battalion should be extended on a line of 400 paces, the proper front of a battalion and of a brigade: the companies in support should remain, each company, in closed line; the companies in reserve should be in line. The second and third battalions should be in lines. The brigade would thus stand on a front of 400 paces; and in the open, and under fire but distant from the enemy, the brigade would have a depth of 900 yards.

In this order of battle there is nothing new to our field exercise. We are accustomed to see a brigade formed with its three battalions on one Line or, at most, on two Lines; but these shallow formations are due to our practice of holding too great a front, and of dispensing, partly or wholly, with second and third Lines. Shallow formations would avail us, and would perhaps be necessary, against a numerous enemy inferior in *morale* and in arms; but only the deeper formation of battalion in rear of battalion could give us the chance of showing the value of our soldiers in a fair field against an enemy worthy of our best endeavours.

IV. *Defence.*

In the open, a brigade would stand on its defence in five lines ordered as above stated. The flank companies of the first battalion would stand on the line intended to be defended. All the formations would be in line, except the two companies in front, which would be extended on a line of 400 paces. In this order the brigade would remain under the cannon-fire preceding the attack of the enemy. This first cannon-fire would be aimed mostly at our guns which would be in line with and on the flanks of our two companies in front. Our infantry would suffer very little from this first fire; whilst they would all be near enough to come up in time to meet the enemy on the line selected for defence.

Our infantry should still be withheld, as long as possible, from the cannon-fire which the enemy would bring to bear upon us from his second artillery positions taken up nearer to our front. Only upon the appearance of the infantry of the enemy within 700 yards of our front, should our two companies commence to fire and our rearmost formations commence to close up. Although they would still for some time be exposed to the cannon fire which the enemy would direct upon us across the front of his attack, our second and third Lines must commence their advance as soon as our two companies have opened fire.

Upon the nearer approach of the enemy, it would be necessary to reinforce our two companies with the supports; to move up the supports nearer to the skirmishers, and the reserve nearer to the supports; to reinforce the skirmishers with two more companies; and, then, to throw the two remaining companies of the first battalion into the skirmisher-swarm. These reinforcements should not be made too soon. Meanwhile, the second and third Lines should have continued their advance; and in their advance, the third Line should have much lessened its distance from the second Line. The third Line, on approaching the front, should form double company-columns. Upon the arrival of the second Line at a distance of 50 yards from the front, and the arrival of the third Line at 50 yards from the second Line, both Lines should advance. The first Line, in skirmisher-swarm, would then get up and lead the charge.

As we are here considering the fighting of a brigade only with reference to a certain order of battle, we do not propose to treat of attacks on a flank of the enemy striving to break in upon our front. We shall content ourselves with saying that some action against a flank of the attack of the enemy is almost necessary to the safety of the defence.

V. *Attack.*

In the open, a brigade should advance with its three battalions deployed in three Lines at distances of 300 yards apart. This would certainly be the best formation in which to advance under cannon fire.

On the arrival of the leading battalion within musketry range, or 700 yards, of the enemy, the two flank companies should run out, extending from their outer flanks, lie down at 300 yards to the front, and fire; Nos. 2 and 7 companies should run out, each company in line, and lie down at 150 yards to the front; and the remaining four companies should lie down in line. The second and third Lines should continue their advance. The skirmishers would then be at 400 yards' distance from the enemy; the supports and reserve at distances of 150 yards to the rear; and the second and third Lines would be closing up.

There should be as little delay as possible in the advance of the brigade. The object is only to get within charging distance of the enemy: to waste the enemy by fire is the proper duty of artillery, both before and during the attack. The skirmishers should gain ground by short runs, and always lie down to fire. The supports, advancing always at the double, and always lying down when not advancing, should gradually draw nearer to the skirmishers and reinforce them as they need reinforcement. The reserve, advancing always at the double, and always lying down when not advancing, should gradually draw nearer to the supports, and replace them, and then reinforce the skirmishers. The second Line should draw nearer to the first Line, and the third Line nearer to the second Line, both Lines lying down when not on the move. The third line should form double company-columns on its passage out of the zone of cannon-fire. All the formations in rear must conform with the movements of the skirmishers; and, at any time during the advance, every formation in rear should be near enough to support the formation next in front.

Before the arrival of our skirmishers within charging distance, or 50 yards of the enemy, the whole of the first Line should be in skirmisher-swarm. When the skirmisher-swarm is within charging distance of the enemy, the advance of the second and third Lines, at distances of 50 yards, will cause the skirmisher-swarm to get up and lead the charge of the brigade.

What is urged against this method of attack is that the leading battalion, sent up to the front in successive detachments to spread along a line of 400 paces, would be a confused swarm, out of hand of the battalion-commander, out of hand of the captains, and not to be trusted to lead the charge. To this we reply that there is no other practicable method of advancing a brigade through the open, to bring it into contact with the enemy; and that men can be trained to act in a skirmisher-swarm as well as they could act in that formation which, within 50 yards of the enemy, should represent what, on parade, is a line. The impulse to charge, when at close quarters, cannot be communicated by word of command of battalion-commander or of captain, nor by sound of bugle, but only by the sight of a wavering enemy, or the resolute advance of a good support. The skirmisher-swarm, leavened by its Officers, would act, not by word of command, but of its own impulse. It is vain now to talk of any better line in front. No line could be marched up to the enemy; and if a perfect line could fall from the skies to find itself near the enemy, it would quickly assume the shape of a skirmisher-swarm. The disorganization of companies in the leading battalion must not be held to be an insuperable objection to the only practicable method of advancing a brigade to attack the enemy.

Again, it is objected that the skirmisher-swarm would not be able to manœuvre. To this we reply, that the skirmisher-swarm would have only to advance, and that it could reform at leisure when its work was done. Infantry have very little manœuvring to do in battle.

The objection that to drill for a loose method of fighting would be injurious to discipline seems almost unworthy of confutation. Much discipline is, no doubt, imparted by steady drill; and our soldiers may still be drilled to approach perfection; but both Officers and soldiers must be taught how to fight. A logical deduction from this objection is, that the discipline of our soldiers is partly dependent upon their stupidity.

VI. *Double Company-Columns.*

By double company-columns we mean quarter columns of four half-companies. A battalion in line would form four double company-columns on the right half-companies of right companies; or two central double company-columns on the right half-companies of Nos. 3 and 5 companies, the two companies on each flank remaining deployed; or double company-columns in the right or the left wing only, the other wing remaining deployed. The change of formation could be made on the move, at the halt, or with the right half-companies of right companies lying down. The columns would usually remain in line at deploying interval, under the direction of the battalion-commander; but a senior captain should command each double company-column much as in cavalry, a captain commands a squadron.

We advocate the formation of double company-columns in third Line not under cannon-fire. This formation would undoubtedly be the best for the first and second Lines to rally upon should they be repulsed in attack or defence. We could usually form our third Line in double company-columns, when it had arrived within 300 yards of the enemy; for the cross cannon-fire of the enemy could seldom be brought to bear on us so close to him. Covered by two lines in front, the third Line would always suffer less from musketry-fire when in company-columns than when in line.

VII. *Conclusion.*

The order of battle of a brigade being as we have stated above, brigades would be placed side by side, not one in rear of another, in defence. Artillery would be placed in the front line in the intervals of divisions, so that guns would be separated from guns by intervals of two battalions, or about 800 paces. Cavalry, and the reserve of artillery and infantry, would be independent of the general order of battle.

In attack, brigades should advance one in rear of another, on a front of 400 paces, rather than side by side. A rear brigade would advance, at 300 yards distance from the rear of the brigade in front, in three lines with distances of 300 yards; and close its lines and lessen its distance from the brigade in front during the advance. An attack should always be prepared by artillery, and then supported by artillery well advanced on the flanks. Deep attacks on a narrow front are the most favourable to the action of the artillery of the attack; and by deep attacks only, can we reasonably hope to bring a superiority of force to bear upon the enemy. Two or more divisions, attacking together, would advance on a front of one division, or 800 paces; but 800 paces is the limit imposed upon the breadth of an attack, by the necessity of having artillery firing inwards across the flanks, in support, and the necessity of arising in superior force upon the enemy in his lines.

SHORNCLIFFE,
19*th October*, 1872.

LECTURE.

Friday, February 16th, 1872.

Colonel H. HUME, C.B., in the Chair.

THE CULTIVATION OF SCIENTIFIC KNOWLEDGE BY REGIMENTAL OFFICERS OF THE BRITISH ARMY.

By Major W. A. Ross, late R.A.

WHILE what may be called the *compulsory* study of the "applied sciences" is more exclusively required by Government from Officers of the Ordnance corps and those of the Medical department, the *voluntary* pursuit of any science is obviously more open to those of the Cavalry and the Line, and these latter have the equal benefit of a sound, gentlemanly education to start from as a basis, and the very great advantage of *leisure time* to enable them to pursue any selected science with success.

The groove of employment which the engineer or artilleryman has to follow in the Service, although not of the high scientific character which their preparatory examination would seem to have suggested, is nevertheless one of severe and incessant work; sufficiently so to debar him from the successful pursuit of any difficult science. In India—I affirm the fact unhesitatingly—these Officers are chiefly employed as cashiers or keepers of public accounts.

Now, cavalry Officers and those of the line have, as a body, a fair knowledge of general science; their regimental and office work is comparatively light, their pay is nearly equal to that of the artillery Officers, while their promotion—in the case of field rank, nearly trebling that pay—is immeasurably superior.*

It is thus that we find such a comparative majority of cavalry, line, and militia Officers coming before the public as inventors, travellers, sportsmen (who, if worth anything, are invariably naturalists), botanists, geologists, mechanists, and what not.

It is obviously to the advantage of Government to select for important appointments, from that body which affords the largest field for selection, and the Line Officers have, therefore, in this fact another great advantage and incentive to scientific study.

An extraordinary opinion or feeling has, until very lately, undoubtedly prevailed among military men, that scientific study of almost any kind, is derogatory to their military character: this fatal folly appears to have been derived from the French army, who, even under Bonaparte in Egypt, held the very word *Savan* a term of contempt or ridicule. Bonaparte himself well knew the military value of scientific knowledge, and made perhaps his most lasting impression on the Turks in Egypt by means of the experiments of the chemist Berthollet. He himself, as is well known, was not only a devoted admirer of science, but a proficient in general scientific knowledge, and was wont, in this very Egyptian expedition, to puzzle the *Savans* he had taken with him—Monge, Berthollet, Cuvier, Lamarck, and others—with such questions as, "Are the planets inhabited? What is the age of the world? "Will the earth be destroyed by fire or water?" One of the greatest soldiers or sailors ever produced by England—Sir Walter Raleigh—was *also* the best chemist and most scientific man of his age; and Napoleon Bonaparte has originated a science—the combination of individual numbers and of masses upon given points—which may easily be applied, and, indeed, has been applied in illustration of the "atomic theory" of chemistry.

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* This was written, of course, before Mr. Cardwell's Bill passed.

Now, of all the "applied sciences," the most generally useful, nay, the most indispensable to any or every profession, is undeniably chemistry, and chemistry also is popularly supposed to possess, of all scientific nuts, the shell hardest to crack. But surely, in its practical and most useful bearing, this is not the case? Viewed in its relation to mathematics, and especially to algebra, chemistry is no doubt an abstruse science, requiring the devotion of a lifetime to make a proficient, and it is possible in this sense, for a clever mathematician who shall take up the study of chemical theories, to write a profound treatise on that subject which might obtain the respect, and even admiration, of "the world of science," without himself performing a single practical experiment. On the other hand, it is also possible for an ordinarily educated and thoughtful man—an Officer of the Army for instance—almost entirely ignorant of all but the most simple and elementary chemical theories, as those of multiple and definite proportions, to procure by mere observant and pleasant experimentation, new combinations of substances which might prove of the utmost value and importance both to science and art.

It is, of course, easy to sneer and say, "Would you have every "Officer of the Army to be a chemist?" To this I would reply, "No, but I would have every Officer employ his leisure time in improving his mental faculties by the study of some science which shall "call most of them into activity, and in this point of view there is "no study equal to that of chemistry."

It will be found, I think, that nearly every practical science depends, for the verification of its results, upon chemistry. Geology and Physics would be puerile if they could not refer to chemistry as the final and "exact" proof of their assertions. Even Astronomy is now laying bare her wonderful revelations of other worlds by means of the chemical analysis of light; and, finally, we must acknowledge that the science of war depends chiefly upon the due appreciation of "villianous saltpetre," or of compounds containing nitrogen.

It may again be asked sarcastically, if I would recommend regimental Officers to carry about with them violent acids and unpleasant precipitants, as a solution of sulphuretted hydrogen, test-tubes, beakers, filters, funnels, and all the fragile paraphernalia which the study of chemistry is supposed to entail? Again I answer, "By no means." I have here in my waistcoat-pocket a little instrument with which, simple as it seems, it may eventually be possible to perform an operation which the most complicated chemical apparatus has apparently failed to effect. I allude to the separation of the rare earth *Lanthanum* (derived from λανθάνω, I lie hid), from what has always been supposed to be, and is sold as "pure oxide of cerium," in which the former had in fact remained concealed, in spite of all the chemical processes to separate the two.

This instrument, as you see, consists of a couple of German-silver tubes, and a smaller one, terminating in a fine jet, with a needle-like hole in it: these tubes fit thus, one into the other, so that they will go into the waistcoat pocket. In my other waistcoat pocket I have two small stoppered bottles, one containing phosphoric, the other boric (formerly called boracic) acid. Having some platinum wire, a candle, and a lens, I am now accoutred as a travelling *geologist*, *mineralogist*, *agriculturist*, or *engineer*, sufficiently so to enable me to perform most of the qualitative analyses of the chemist, only otherwise possible with the acids, filters, test-tubes, &c., above referred to.*

This simple little tool—so different from the startlingly complicated machines one finds in the laboratory of the chemist or the *atelier* of the natural philosopher—pictures of which you will find *ad libitum* in Ganot's Physics—is, as I think, stupidly called a "blowpipe." But, however that may be, my business to-day is not with its name, but with its extraordinary utility, and with the unparalleled elegance and rapidity of its operations, which, in my opinion, fairly entitle it to be the humble but invaluable companion, not only of the wandering philosopher, of the Officer and engineer in the field, but even of the lady in her boudoir, for, avoiding the unpleasant and unwholesome smells which chemical operations entail, the results of this study, from which the student can draw scientific conclusions as accurate as marvellously rapid, are chiefly given in the shape of coloured beads or glasses, little inferior in brilliancy and hue to the gems of which ladies are so fond. I mention this fact especially, in acknowledgement of quite an unexpected pleasure afforded by the presence of so many ladies in this room. The magnificent translation of Dr. Schellen's work on Spectrum Analysis, just published, made by two young ladies, Jane and Caroline Lassell, shows how importantly the ladies can, if they like, assist in the dissemination of scientific knowledge.

One thing I must here mention—that this study, which I have ventured to call "Pyrology," is scarcely one for a public lecture-room. The very fact which constitutes one of the chief advantages of pyrological operations—the extreme portability of its apparatus—causes its results to be almost microscopic, and therefore unfit for exhibition before a number of auditors; and another disadvantage under which I labour to-day is, that having at present only a mouth "pyrogene"—as I propose to call the blowpipe—I cannot, of course, speak and use it at the same time; but a cheap, portable, and elegant blowing apparatus of vulcanised india-rubber is now made at Freiberg, in Saxony, which will enable the most delicate young lady or dandified Officer—for a great many clever men are also dandies—to use this invaluable little instrument without the facial disfigurement caused by using the mouth blowpipe.

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* It is said that Dr. Wollaston, who was a proficient in the use of the blowpipe, placed the whole of his chemical apparatus on a small tea-tray.

To do the best I could, however, I have prepared beforehand a number of these "glasses," or "beads," of the before-mentioned phosphoric and boric acids—which, by the way, can be procured at any respectable chemist's shop, even in out-of-the-way stations, as those of India—by heating them thus, before the pyrogene, upon small pieces of platinum wire, twisted at one end into a loop or ring. You see that the acid, or "flux," as it is called, becomes quite red-hot, and thus, acted upon by the blast as well as by the conical blue flame proceeding from the front or jet of the pyrogene,—called by me a pyrocone,—revolves or spins round upon its centre with a rapidity which, avoiding as far as possible long words, has been found to be proportional to the fluidity of the matter of which it is composed. It must be quite evident, therefore, that any substance added to this red-hot bead in order to be dissolved in it by the combined action of the acid and the intense heat of the pyrogene, will be rapidly turned round—just as, only much quicker than, a leg of mutton is before a kitchen fire—so that every portion of the substance will be subjected to an equal degree of heat.

The bead I have now taken is one of *phosphoric acid*, which, as we all know, is present to an alarming extent in all our bones, and the doctors say in our brains also, especially in those of lunatics, but that I cannot believe!

You see at present that it is beautifully clear and colourless, and in its platinum wire setting looks something like a round diamond in silver. Now on applying the point of this blue pyrocone to it, you observe that is red-hot, and while in this state I just apply it thus to one of the small pieces of gold leaf lying on this slab of agate, and again bring the *other* side of the bead to the point of the blue pyrocone. The piece of gold, as you see, has disappeared, the platinum wire is apparently unaltered, and the bead or glass is as clear as ever, and even more brilliant; the gold, unable to stand the combined heat and powerful acid, has been utterly dissolved, and I have now here a brilliant colourless solution either of gold or of the oxide of gold. It will be very easy to prove which it is, although we shall now be treading on ground hallowed by the investigations of Faraday's mind, and even be compelled by the force of facts to hold an opinion different from that of the immortal philosopher on the subject,* for observe, I have now taken up several small pieces of gold leaf and dissolved them in the bead, to which I now add a little more phosphoric acid, and hold it *not quite so far* as I have been doing from the point of the blue pyrocone. I will now ask some one near me to observe this auriferous brilliant glass while it is getting cool. There is no change—but the glass is not nearly cool yet—but now, see! it flushes over with a most beautiful bluish rose colour, as pretty as that of the finest amethyst. Many of my fair hearers would give much to have a gem like this for their rings, but unfortunately this ruby bead will not last, as the bead will soon become sticky and unpleasant by absorbing moisture from the atmosphere. On the other hand, what would not the illiterate digger of Australia give to have a simple and rapid (as well as beautiful) test like this for the gold he may suspect to lurk in the crushed quartz?

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* Faraday held that the ruby colour bestowed by gold upon glass and fluxes is due, not to the *oxide* of that metal, but to *metallic gold* in an infinitely small state of division: the above experiment proves that it is due to an *exact* amount of oxidation of the gold.

Here is another "glass" of the same flux. It looks quite clear also, and even after making it red hot by holding it a long way from the point of the blue pyrocone, you see that it remains quite clear and brilliant. You will probably guess from this fact, that there is nothing dissolved in this bead, and if so, you will be very far from the truth. There is at least 5 per cent. of the oxide of *silver* dissolved in it, and now, mark the effect of my holding it just inside the tip of the blue pyrocone; the bead is a perfect image of a fine *pearl*, and this beautiful reaction is an excellent test for 5 per cent. of the oxide of silver.

I now take another glass, also clear, and in no way distinguishable from what the others were at first. It is, however, composed of a very different, though analogous substance—*boric acid.* It is the substance which apparently separates those rare earths of which I spoke, *cerium*, *lanthanum*, and *didymium*, when they are all combined in the so-called "pure" ceric oxide; I am not, however, going to trouble you with such long names, or such slippery substances, about which I know as little as any one else appears to know. Instead of this, I heat this clear glass as before, and having applied a mere trace—there must be no more—of our old friend phosphoric acid to it, heat the whole again. Watch it as it cools. You see that in about five or six seconds it clouds over, but a yellow light still shines from within, causing the bead to be an almost perfect imitation of the noble opal; could this be only kept in its present state, it would not disgrace the fingers of the ladies. This is a rapid test for phosphoric acid in minerals, which acid I have little doubt is the cause of the unique beauty of the opal, at present attributed to "organic matter."

Time will not allow me to show you a tenth part of what I should like to do, in illustration of this elegant—and, as I believe, important—mode of analysing inorganic substances, but I cannot refuse myself the pleasure of showing you what I really think was a valuable discovery made by myself in India, in 1869.

Here is another glass of phosphoric acid. I am going to dissolve in it some oxide of the metal *cobalt*, known, I presume, to most present as the substance which gives to glass and porcelain the beautiful blue colour, *bleu de roi*, which we have often seen; and indeed it is just in this fact that I consider I may fairly call the experiment I am about to make a "discovery," for in all "blowpipe" tables and chemical works of the present day, you will find the chromatic reactions of cobalt given as blue, and blue only.

Now observe the difference. You will say "What difference? the glass is only blue;" but wait awhile, it is only half cool. You see as it cools to what a charming colour it changes: a deep purple violet, as we should call it, or, as the ladies would call it, "magenta." I now add to this bead a little common salt, and heat all together. You see the glass now *remains* blue when cool, and this is effected by the sodium of the salt, for just 17 per cent. of soda or potash will cause this beautiful red glass to remain blue on cooling, causing it to be a valuable measure of alkali in substances, or an *alkalimeter* which you can put into your waistcoat pocket.

I must now conclude, but before doing so, I would ask your attention for a few moments to these parcels of earth spread on the table before me, the meaning or use of which you will probably have been trying to conjecture. They represent various specimens of the substance which the Government of India has for the last 10 or 12 years been using as a *limestone* in the manufacture of the mortar with which their vast and palatial double storied barracks and other public edifices have been built.

Now by this "limestone" there hangs—as Shakespeare and Darwin tell us—a tale. It is found throughout almost the whole of the vast plains of India (and nowhere else, I believe), occurring from 6 to 10 feet below the surface of the ground, in what the geologists call concretionary tufaceous nodules, or something like that, but the illiterate natives have applied to it a much shorter name, "kunkur," by which it is now universally known.

Lord William Bentinck, when Governor-General of India, first applied this "kunkur" to a purpose for which it is admirably suited, that, namely, of "road making," in which it is hammered and crushed upon the public roads with water until it forms a paste, which is shortly baked by the powerful Indian sun into a kind of porcelain coating or "metalling," as it is technically called, and which is so hard as to form the finest roads in the world. It is said—but please don't repeat it—that his lordship was ever afterwards called "William the Kunkurer," but the author of this atrocious pun has, it is hoped, been secured and deposited in Hanwell.

Some one—I don't know who—without the perception of Lord William Bentinck, suggested the use of kunkur as a limestone for making mortar, for which the kinds generally found are quite unfitted, as they only contain 20 per cent. of lime, and even that is bound up in a peculiar way with silica, so as to make the whole utilisation of the lime by burning difficult, or even impossible. This kunkur has been treated by the Indian Government in the manufacture of the mortar of their "palaces of cards," as though it were a pure limestone, for they mix one-third of it with two-thirds of pounded brick (called "soorkhee"), or with common earth. I am sure that nobody present will deny that 20 is one-fifth of 100, so that the Indian mortar contains only one-third of one-fifth of lime in 100, that is one-fifteenth!

I now heat with the pyrogene a specimen of good limestone mortar, taken from a private house at Mussoorie, in India. See how it glows. By putting, now, a drop of this cobalt solution upon it while still hot, you see that it turns immediately a pretty blue. Now let us try this "mortar," taken by myself from the wall of one of the palatial tumble-down barracks above referred to, in the same way. The cobalt solution does not change its appearance in the least, but it remains very much like a substance too common in the streets of London—mud. The barrack from which this specimen of "mortar" was taken, cost more than £10,000; it has a fearfully heavy roof of stone, and on the occasion of a high wind, after rain, a company of the 88th, as I am informed, rushed out of it, declaring they would stay no longer in it, as it was dangerous. Now this is by no means a solitary instance, but, on the contrary, *all*, or nearly all, the later barracks, post offices, and public buildings between Calcutta and Peshawur have either fallen down, are unsafe, or are just kept habitable by constant repair at an enormous expense.

In one instance, a steam-engine from England was put up in one of these buildings at Allahabad, which, at the first stroke of the piston, came, as was to be expected, to the ground, killing several people, and wounding more. This was too much even for the good nature of the late Lord Mayo. He ordered the "mortar" to be sent to Calcutta to be analysed, and the analysts found in it the economical proportion of just 5 per cent. of *lime!*

It has been published in the newspapers, and never contradicted in India, that the total amount of public money thus wasted on these buildings during the last ten years is no less than £45,000,000!!

The Indian Government attributed the fact (which is not denied) of the failure of these buildings, to their Officers in the department of Public Works having been cheated as to the lime by the native contractors, and removed several of the former from their appointments, but the cause evidently lies—as above explained—in the use of this *kunkur* as a pure limestone, which use was *ordered* by the Indian Government itself.

If I have not trespassed too long on your patience, I will just add a few words to show how such humble knowledge as that I have described may become important to a Government which is not above making use of it. I see on one of the back benches, a gallant Officer who, as I remember, applied to the Chief Engineer in Bengal—a Colonel of the Engineers whose name I forget—for me some twelve years ago to join the Department of Public Works in India; the reply received was in the negative; but I had at that time, brought to India from Freiberg, one of Plattner's complete blowpipe apparatus, with assay balance, &c., and I cannot but believe that had the Government then accepted my services, I might at least have been able to have convinced them of the real nature of the *kunkur* employed, and thus have had the satisfaction of adding my mite towards a knowledge that would have prevented the series of colossal failures in public buildings above adverted to, of which the barracks at Saugor—which cost a trifle of £166,000—are the latest instances *brought to light;**

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* These barracks are, according to the *Times* of December 3, 1872, ordered to be

but there is no doubt that *all* the later barracks and public buildings in Bengal and the north-west of India, are in the same unsatisfactory state.

Thus you see that a little of the scientific knowledge I have here attempted to indicate, might have saved the Government of India some *forty millions sterling!*

THE AUTUMN MANŒUVRES OF THE PRUSSIAN GUARD-CORPS IN SEPTEMBER, 1872.

Communicated by Lieut. HENRY J. T. HILDYARD, Adjutant 71st H.L.I.

NEARLY two years have already elapsed since the grand review of the German Army at Longchamps previous to its homeward march, and since that time there had been no considerable assembly of German troops for the purpose of exercising until the manœuvres of the Guard Corps in the vicinity of Berlin during the month of September of this year. There is every reason therefore to look upon these manœuvres, carried out without hurry and with sufficient preparation, as specimens of the results drawn by the Germans after a careful consideration of their experiences during the late war. We cannot indeed regard any new movements practised, as their definite conclusions, for no new instructions have been issued since the war, but we may take great interest in watching what are still with them only tentative measures, for under these circumstances we are the more likely to see their defects, and to hear them freely discussed by themselves as well as by others.

As has been explained very frequently of late, there is a considerable difference between the German peace-manœuvres and our own, inasmuch as the former adopt a system of billets, which necessitates prearrangement, and limits the movements to certain bounds. But apart from this, it is not always considered equally instructive for one manœuvre to last for several days on a very extended scale, as in that case the instruction derived is in a certain degree restricted to a limited number of Officers in high command, whose plans but too often become common property and are subject to free discussion long before they are put into execution. A great portion of the time also in this case is necessarily occupied by strategical marches which, although of

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abandoned, and the constructor, Captain Faber, R.E., to be dismissed from the Department! Poor man; *he* was not to blame.—W. A. R.

NOTE.—The lecturer has received the honour, since this lecture was delivered, of having his paper on "Pyrology, or Fire Analysis," read before the Royal Society, in Vol. xx, No. 137 of the proceedings of which Society it will be found, and may be referred to by those desirous of more detailed information on this subject, which, however, cannot be found in any of the published works on the "Blowpipe," as the fluxes and their reactions above mentioned, were introduced by the writer in 1869, and have been used by him only, as yet. A work on the subject will shortly be published by Messrs. Spon, of Charing Cross. Messrs. Horne and Thornthwaite, of Newgate Street, will supply the apparatus required in this method of analysis to Officers at a moderate cost.

undoubted value, can be practised equally well by brigades and lesser bodies of troops. The usual German plan which is to manœuvre from day to day with fresh dispositions and fresh aims, although the original general idea is often adhered to, affords a series of varied and definite lessons to those in high command, and gives at the same time a greater amount of practice to the subordinate Officers and men.

It has been said, that in peace-manœuvres, so soon as the two opponents come into close contact, the game is at an end; but I do not consider that this is strictly the case, except perhaps from a strategical point of view. Undoubtedly the student of pure strategy will feel that his study is more or less at an end, but tactics take its place, and though many of the elements which would decide perhaps in real war are wanting, sufficient remain, the proper employment of which, require most careful and continual study. Were movements to be checked so soon as the two conflicting forces were deployed for action, not only would an opportunity be lost for the working out of tactical problems which vary so much according to the ground and many other considerations, and which nevertheless require fixed general outlines, but no practice would be afforded in the very difficult matters of pursuit and retreat.

Hoping that my preface will be sufficiently accounted for by a desire to call attention more especially to the subject of tactics, which is the branch I propose to treat of, I will now proceed to describe as shortly as possible the two greater manœuvres of the Guard-Corps in the vicinity of Berlin on the 9th and 10th of September, the former of which consisted of a manœuvre of the entire corps against an imaginary enemy, and the latter of one in which it was divided into two parts, acting one against the other.

Manœuvre of Corps against Imaginary Enemy, September 9th, 1872.—*General Idea.*

The Guard-Corps has been brought up to the relief of the invested fortress of Spandau. On its approach, the enemy having raised the siege and evacuated the left bank of the Havel, takes up a position in the vicinity of the fortress on the right bank with considerable forces, in order to cover the withdrawal of his siege material.

Special Idea.

The commander of the Guard-Corps having advanced with the main body of his forces, close up to Spandau on the night of the 8th September, and pushed his advanced guard through the fortress upon the right bank of the Havel, decides to attack the enemp's position on the heights west of Staaken and Amalienhof on the 9th, turning his right flank, and to force him to retreat before he can secure his siege material.

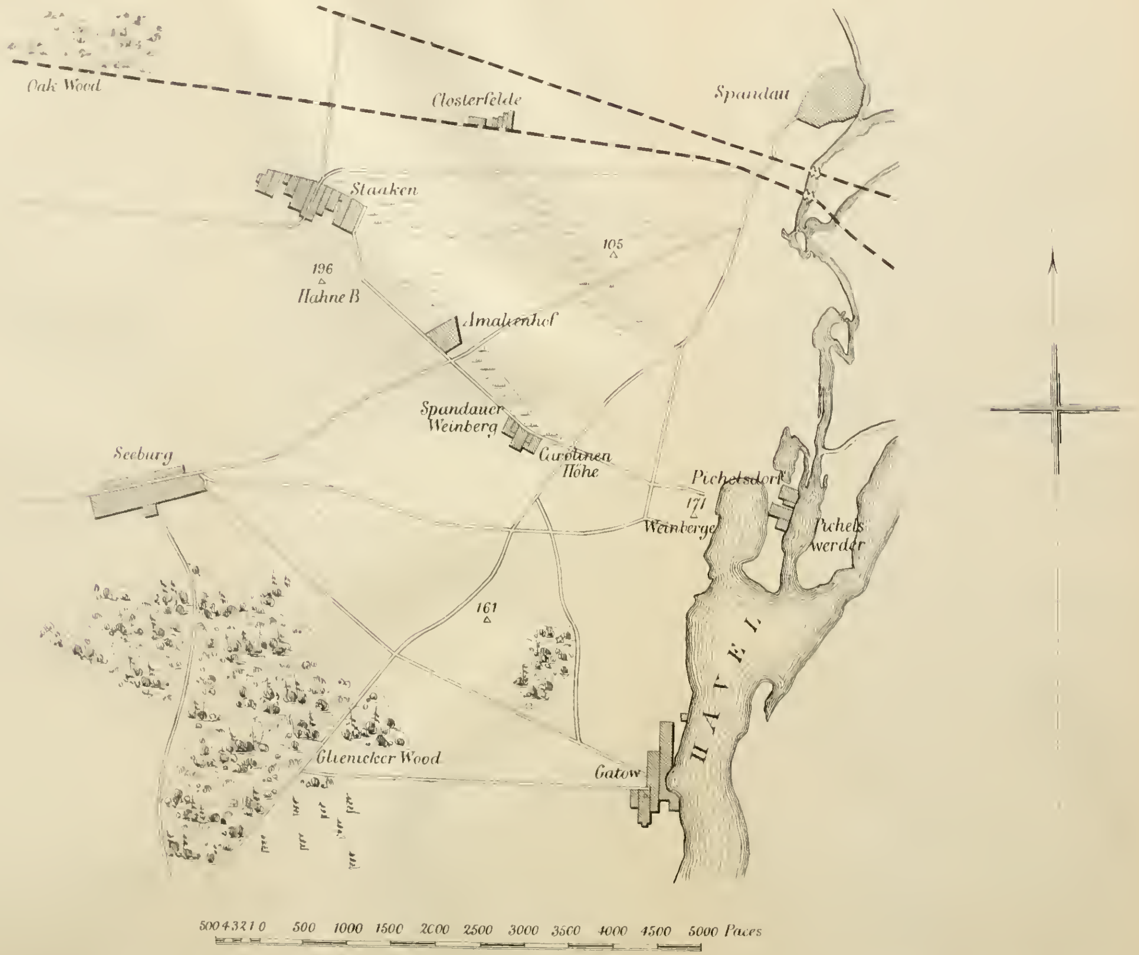
Partition of Troops.

1st Infantry Division, Lieut.-General v. Pape.

1st Infantry Brigade { 1st and 3rd Foot Guards.
Jäger battalion.

PLAN FOR CORPS MANŒUVRE OF PRUSSIAN GUARD

Berlin September 9th 1872.



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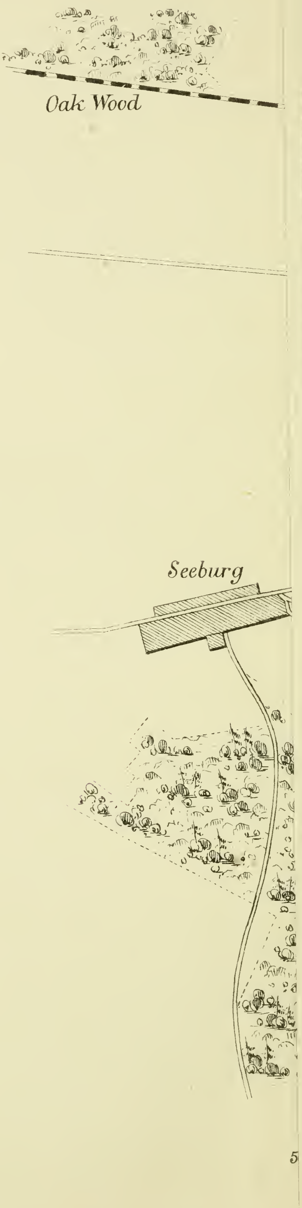


2nd Infantry Brigade: 2nd and 4th Foot Guards; Hussar regiment.

1st Foot Division of the Field Artillery Regiment (4 batteries of 4 guns).

2nd Infantry Division, Lieut.-General v. Budritzki.

3rd Infantry Brigade	Emperor Alexander's Grenadier Regiment. 1st and 3rd Queen Elizabeth's Grenadier Regiments. Rifle battalion.
4th Infantry Brigade	Emperor Francis Joseph's Grenadier Regiment. 2nd and 4th Queen Elizabeth's Grenadier Regiments. 1st Pioneer Company.

2nd Uhlan Regiment.

2nd Foot Division of the Field Artillery Regiment (4 batteries of 4 guns).

Corps Artillery: Colonel v. Helden-Sarnowski.

3rd Foot Division of the Field Artillery Regiment (4 batteries of 4 guns).

Horse Artillery Division of the Field Artillery Regiment (2 batteries of 4 guns).

Left flank detachment, Major-General Baron v. d'Goltz.

Fusilier regiment and combined infantry regiment.

Three companies Pioneer battalion, with light field bridge train.

1st Brandenburg Uhlan regiment.

Instruction battery from School of Gunnery (4 guns).

Cavalry Division—

1st Cavalry Brigade	Gardes-du-Corps regiment. Cuirassier regiment.
2nd ,,	1st and 3rd Uhlans.
3rd ,,	1st and 2nd Dragoons.

1st Horse Artillery battery (4 guns).

Disposition.

Head-quarters, Spandau,
8th Sept. 1872, 5 *o'clock p.m.*

The Guard Corps will attack the enemy's position on the heights of Staaken and Amalienhof to-morrow, turning his right flank.

The first infantry division and the corps artillery, the latter following the foremost regiment of the main body, will debouch from the Potsdam gate at 8.30 o'clock. The division will form up for the attack of the Amalienhof heights and the Spandauer-Berge, supported by the corps artillery, which will march near its right.

The second infantry division will begin to debouch from the Aranienburg gate at 8.15 o'clock, and will push forward its advanced guard against Closterfelde and Neu-Staaken in order to possess itself of these places and engage the enemy on the heights. The main body will advance 1500 to 2000 paces in rear of it, and form temporarily the reserve of the corps for my disposition.

The left flank detachment will protect the throwing of a bridge from Pichelswerder to Pichelsdorf, which must be finished by 8 o'clock, and at 8.30 o'clock it will be directed by the latter place towards the Carolinen heights, keeping somewhat in advance of the left of the first infantry division, reconnoitring towards Gatow and Gr. Glienicke.

The cavalry division will cross the pontoon bridge immediately after the flank detachment, and will form up in rendezvous formation, fronting towards Seeburg, and covered by the Carolinen Heights. Reports will find me with the main body of the first infantry division.

(Signed) AUGUST,
Prince of Wurtemburg.

The greater portion of the Guard-Corps had bivouacked on the afternoon of the 8th. The main body of the first division was at Charlottenburg and Ruhleben, and a small portion was cantoned in Spandau. The main body of the second division bivouacked south of Haselharst, the advanced guards of both divisions west of Spandau, the left flank detachment in the Grunewald at Pichelsberg, from which place a bridge of boats had been formed to Pickelswerder, a small island in the Havel, occupied by a battalion in the Fusilier Regiment.

Early on the 9th September, the advanced guards of both divisions were ready to commence the forward movement, the first close before the Potsdam Gate, with posts of observation on the other side of the suburb, that of the second about 1,000 paces west of the Spandau works on the railway leading to Hamburg and Lehrte.

The left flank detachment had in the early morning constructed a pontoon bridge and a bridge of casks from Pickelswerder to the right bank of the Havel, the former of which was utilised for the passage of the infantry, the latter for the other arms. At the given times, the heads of the respective columns were set in motion.

The advanced-guard of the second division on the right formed up from column of march as a first attack, which was subdivided into three lines in the following manner:—In the first line was a subdivision of each of the two leading companies of battalions extended in skirmishing order, followed in second line by the remainders of these companies in section-columns about 40 paces apart and 100 paces from the extended line. The third line was composed of the remaining companies in half battalion formation, about 200 paces more retired. The advance here was carried out without opposition, ground being gained for the main body to form up, the villages of Closterfelde and Neu-Staaken being occupied, and the enemy's attention called to this flank, which was the immediate object in view, so as to allow of the turning movement on the enemy's right being developed without serious opposition.

At the same time the advanced guard of the first division, covered by the fire of its battery, which was escorted by a portion of the Hussar Regiment, formed up whilst advancing over the open ground in its front, and gained sufficient ground along the road leading to the Carolinen Heights to allow the main body time and space to deploy.

The Corps artillery went rapidly forward in the meantime to an advanced point (105) between the two divisions, where it formed up and opened a continuous fire upon the heights occupied by the enemy, about 2,000 paces to its front.

The left flank detachment was at this time marching upon Seeburg; the cavalry had not completed the passage of the stream.

As soon as the first division had completed forming up, which it did in two lines of battalion-columns at full distance, the brigades side by side about 100 paces in rear of the guns, with the regiments in rear of each other, and 50 paces apart, it prepared for advance in the following manner. The foremost line sent two companies per battalion to the front, which formed three lines, the first two in extended order, with barely half-pace intervals between men, the third in sections in close-order. The remaining two companies of the battalions of the original first line were in half-battalion formation, forming a fourth line, whilst the regiments in the original second line formed a fifth line, composed of battalion-columns at full interval. This formation was completed in rear of the guns, the first line being aligned with them, and as soon as sufficient effect was considered to have been produced by the artillery-fire, the cavalry passed to the front to clear the ground. The general advance of the division then commenced by echelon from the left, which was composed of the second brigade. This advanced by moving off in the first place its first lines, followed by the second at a distance of 80 paces, the third following at an interval of from 100 to 150 paces, followed by the fourth at about 300 paces; the fifth line followed considerably in rear. This movement was supported by a battery on the left belonging to the flank-detachment, which was ascending the heights north of Gatow, and advancing towards Seeburg. Advancing rapidly by running forward, and lying down at intervals, this brigade carried the Carolinen heights, whilst the first brigade, forming the right, advanced against the Spandauer-Weinberge, which were quickly occupied, assisted by the fire of the second brigade from its new position. The divisional artillery now moved forward on to the heights and opened fire against the Hahnenberg, whilst the Hussar regiment followed the retreating enemy, and the first brigade possessed itself of Amalienhof, close to which the artillery took up a still more advanced position, and continued to fire rapidly in the same direction.

About the same time the left flank detachment, which had been advancing with slight opposition towards Seeburg, proceeded to its attack, which was done by an advance of the infantry very similar to that of the first division. Advancing to the close vicinity of the village, the whole lay down, the first line being reinforced by both the second and third, and a very rapid independent fire opened. An advance was then made by subdivisions, which fought their way through the village, the divisional cavalry coming to the front and pursuing for a short distance on the other side. The Corps artillery having been released from its first object by the occupation of Amalienhof, now advanced to a position between the latter place and Staaken, whilst the artillery of the second division formed up on its right. That of the first division was already posted on the heights, and the battery of the left flank detachment and of the cavalry division was near Seeburg. From these points the fire of the whole of the artillery was now concentrated upon the position Hahnenberg-Staaken, whilst the infantry prepared for the final advance, with the exception of the main body of the second division, which moved off to its right in the direction of the Oak Forest.

The final attack was now made by the first division and the advanced guard of the second. This was carried out in the original loose order by rapid and short advances, the extended lines breaking up into groups on arriving at close quarters, and pushing steadily forward, with the exception of one regiment in column of companies on the centre. Whilst this was progressing, the left was advancing to the left of Seeburg. As soon as the enemy's retreat was decided, the cavalry, which had been kept back in a sheltered position behind Seeburg, advanced in columns of squadrons, the Cuirassier brigade on the right, the Uhlan brigade on the left, and formed up in two attacks, four regiments in first line and two in second. The former rode straight forward to the attack towards the chaussée, reining up only when close to it, whilst the latter turned to its left to meet the enemy's cavalry, supposed to have been pushed forward on his right flank, and which was already suffering from the fire of the flank-detachment battery.

At the same moment that the cavalry was re-formed, the general halt was sounded, which brought the manœuvre to a close, when the troops stood in the following positions:—

The advanced guards of both divisions in an alignment with the artillery advanced close up to the road leading from Staaken to Dallgow, whilst the main body of the second division had reached the Oak wood. The main body of the first division was drawn up on the Hahnenberg.

The simplicity of the plan and the evenness of the ground allowed every movement to be followed with comparative ease, though, owing to the large extent of the front, it was not possible to witness personally every detail.

The manœuvre of the 10th September consisted of one division acting against the other, the general idea being drawn from the results of the manœuvre of the previous day. The corps was divided into an east and a west division, the former of which represented the attacking force of the day before, or a portion of it at least, and the west division, the retreating enemy.

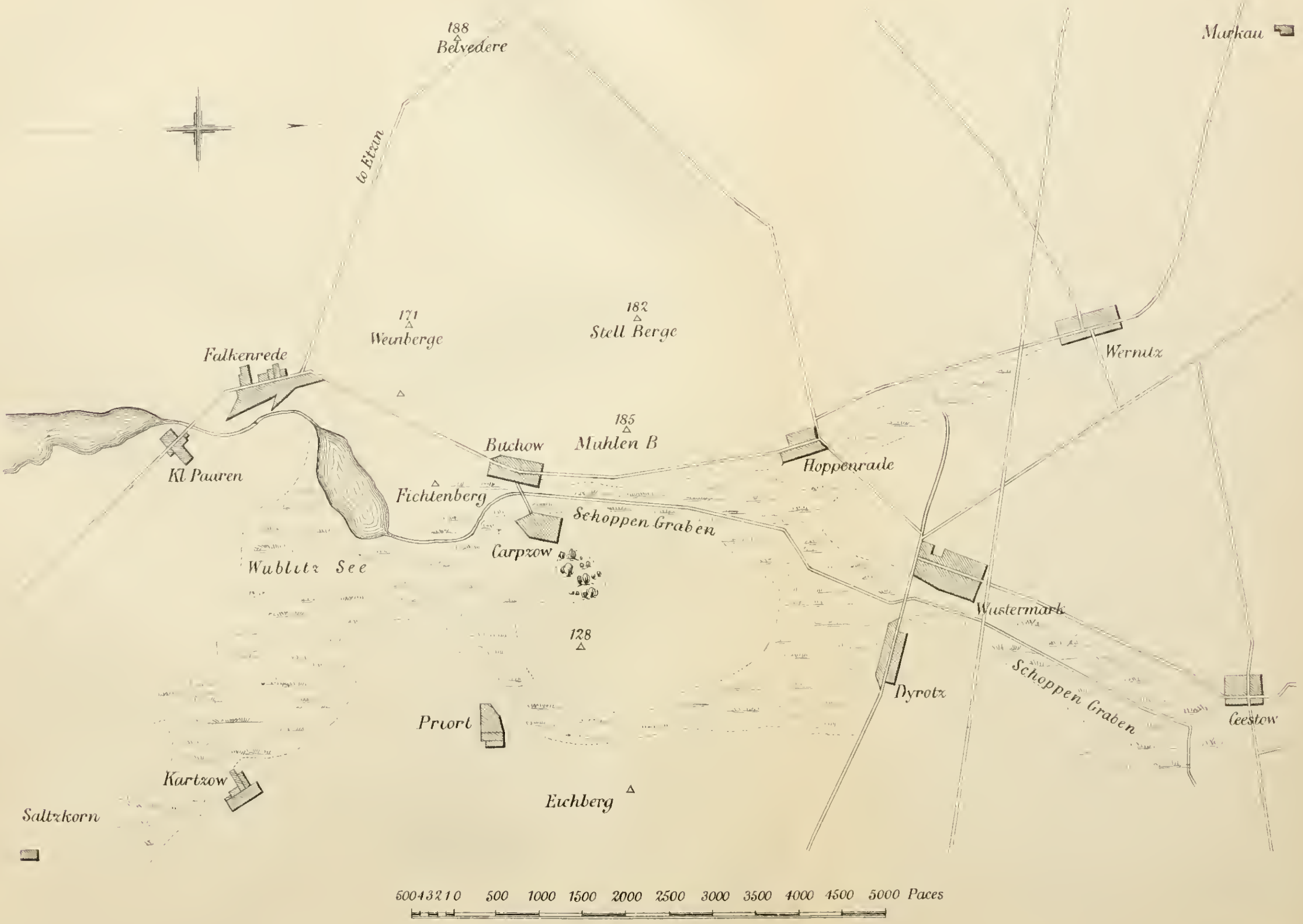
Special Idea for the West Division.

The west division having been forced to retire from its position on Hahnenberg, on the 9th September, by very superior forces, and been closely followed, continued its retreat over the Schöppengraben. Weak outposts still maintain themselves to the east of it, as the enemy has only advanced a short distance beyond the line Ferbitzer-Bruch and Rhins-hake.

The divisional commander is instructed to maintain the defiles over the Schöppengraben until noon, on the 10th September, and then to

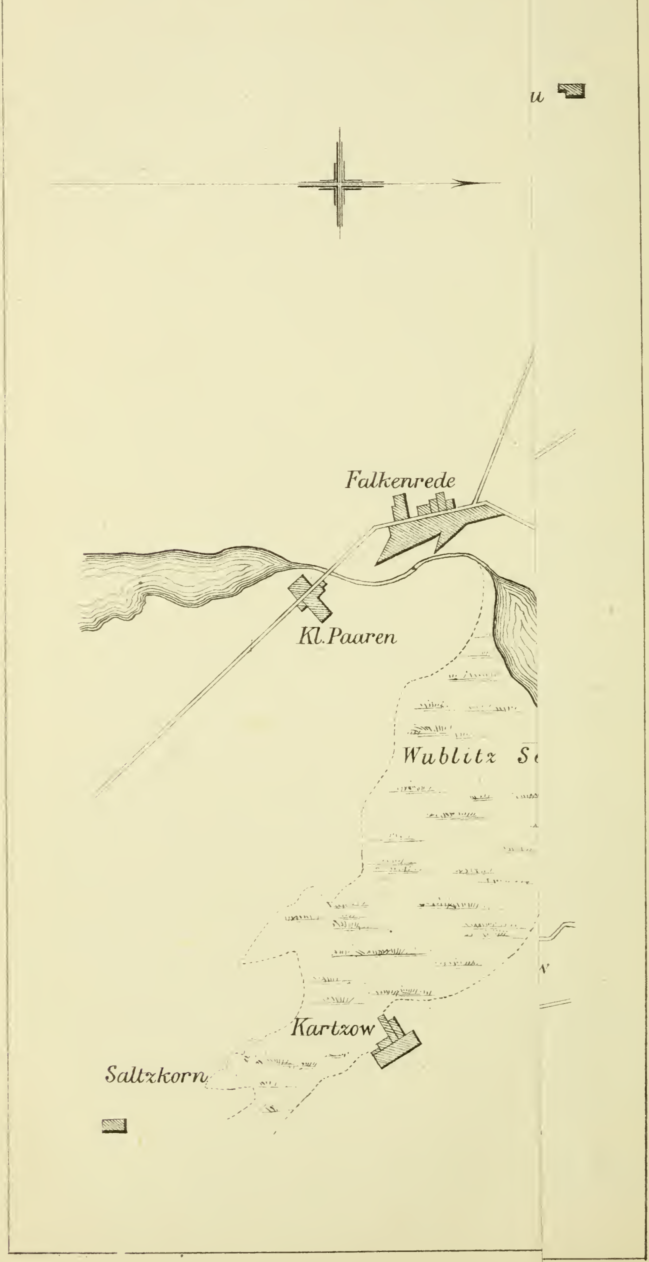
PLAN FOR MANŒUVRE OF PRUSSIAN GUARD_ DIVISION AGAINST DIVISION.

Berlin, September 10th 1872.



J Jobbins

PLAN FOR MANŒUVI



J Jobbins

retire in the direction of Brandenburg, leaving only posts of observation in front of the enemy.

Special Idea for the East Division.

The Guard Corps, after having beaten the enemy's investing corps on the forenoon of the 9th September, on the heights south-west of Spandau, received at noon the order to detach the second cavalry brigade and a portion of the first division, strengthened by the corps artillery, in the direction of Potsdam, whilst the second division and cavalry division, and a great portion of the corps artillery, is formed into an east division, for the purpose of following the enemy in his retreat upon Nauen.

In the evening the outposts stand in the ground close to the west of the Ferbitzer-Bruch and Rhins-hake, the main body east of the Schweinekuten-Graben. Weak posts of the enemy are still to the east of the Schöppengraben. The commander of the east division receives the order to attack the enemy (west division) again, and by pressing on his right flank, to endeavour to throw him into the Havelbruch.

The heads of the advancing columns are not to cross the line of outposts before 9 o'clock in the morning.

Disposition of the West Division for the Manœuvre of 10*th September,* 1872.

Staff-Quarters, Hoppenrade,
9th September, 1872.

The division has crossed the defiles of the Schöppengraben, at Dyrotz, and Buchow-Carpzow to-day, and bivouacked with the infantry between Wustermark, Wernitz, and Hoppenrade, the cavalry and artillery at Hoppenrade.

The advanced guard is posted as follows :—

2 battalions, 1 company Jägers, 1 squadron, 1 battery, at the Windmühle.

1 battalion, 1 company Jägers, 1 squadron, 1 battery, at Buchow-Carpzow.

1 company Jägers, 2 sub-divisions Hussars, in Ceestow and Bredow.

1 company Jägers, 1 sub-division Hussars, in Falkenrehde.

The remainder of the Hussars immediately to the west of Dyrotz.

The Pioneer detachment in Dyrotz.

The outposts somewhat in advance of this line.

The bridges over the Schöppengraben, at Falkenrehde, on the way from Buchow-Carpzow to Doeberitz, at Ceestow and Bredow, are so far destroyed as to only allow of the passage of patrols, and are prepared for complete destruction.

In this position the division will endeavour to defend the Schöppengraben until noon, and then retire upon Brandenburg by Nieselde and Tremmen.

The advanced guard will give early information regarding any movements of the enemy.

Partition of Troops.

Commander: Lieut.-General v. Pape.
Officer of the General Staff: Captain v. Nickisch-Rosencgk.
Aide-de-Camp: 1st Lieutenant Brunsig Edler v. Brun.
Advanced Guard: Colonel v. Papstein.
Fusilier Regiment: Major v. Feldmann.
Jäger Battalion: Major v. Arnim.
Hussar Regiment: Colonel v. Hymmen.
5th Light and 5th Heavy Foot Batteries: Captain Gizycki.
1 Pioneer detachment.
Main body—
1 Infantry Brigade: Major-General Count v. Kenitz.
3rd Foot Guards: Colonel v. Thile.
1st Foot Guards: Colonel v. Boehn.
2nd Infantry Brigade: Major-General v. Krosigk.
4th Foot Guards: Colonel v. Grolman.
2nd Foot Guards: Colonel v. Appell.
1st Foot Division of the Field-Artillery-Regiment, Major v. Heineccius.
2nd Cavalry Brigade: Major-General Prince Hohenlohe-Ingelfingen.
1st Uhlans: Colonel v. Eller-Eberstein.
3rd Uhlans: Colonel v. Schenck.
1st Horse Artillery battery.

(Signed) v. PAPE,
Lieut-General Commanding 1st Guard,
Infantry Division.

Disposition of the East Division for the Manœuvre of the 10*th September*, 1872.

Staff Quarters, Doeberitz,
9th September, 1872, 6 *p.m.*

The defeated enemy has retired behind the Schöppengraben, towards Nauen; weak outposts stand to the east of the former.

The east division will attack the enemy again to-morrow, and pressing him from the direction of Brandenburg, will force him upon Nauen, or into the Havel morass. The first column will pass the line of outposts at 8.30 a.m., and close the defile Dyrotz-Wustermark, against a possible offensive. The second column will cross the advanced posts at 8.30 a.m., and march upon Carpzow by Priort, and will secure the Buchow-Carpzow defile. The infantry of the third column will be north of Ferbitz, at 8.30 a.m., the two cavalry brigades, the artillery, the pioneer detachment, with the bridge material, and the sick transport waggons, will be ready at 8.30 a.m., with the head of the column at the Schaafdamm bridge. The column will go by Satzkorn (the infantry by Kartzow, where a bridge will be thrown), and Klein-Paaren to Falkenrehde. The column will clear the Carpzow-Buchow defile for column No. 2, and hinder the enemy in his retreat upon Brandenburg.

I shall be with the second column.

Partition of Troops.

Column No. 1.: Major-General v. Knappe.

Emperor Alexander's Grenadier Regiment (No. 1): Colonel v. Zenner.

Rifle Battalion: Major v. Böltzig.

3rd squadron: 2nd Uhlän's, Colonel v. Rochow.

6th heavy battery.

Pioneer detachment with two intrenching tool waggons.

Column No. 2: Major-General v. Dannenberg.

Emperor Francis Joseph's Grenadier Regiment (No. 2): Colonel v. Wangenheim.

Queen's Grenadier Regiment (No. 4): Colonel v. Lucadou.

Queen Elizabeth's Grenadier Regiment (No. 3): Colonel v. Hüllessem.

2nd Squadron: 2nd Uhlans.

2nd Foot Division Field Artillery Regiment and 6th Light Battery: Major v. Krieger.

Pioneer detachment with 1 Trestle bridge waggon.

2 sick transport waggons.

Column No. 3: Lieutenant-General Count v. Brandenburg.

Combined Infantry Regiment: Colonel l'Estocq.

1st Cavalry Brigade: Colonel v. Krosigk.

Gardes du Corps Regiment: Colonel Count Hynar.

Cuirassier Regiment: Major v. Kleist.

3rd Uhlan Regiment: Major v. Möllendorff.

3rd Cavalry Brigade: Colonel v. Brandenstein.

1st Dragoons: Lieutenant-Colonel v. Brozowski.

2nd Dragoons: Major v. Lützow.

Horse Artillery Division of the Field Artillery Regiment (2 batteries): Major v. Graevenitz.

Instruction battery: Pioneer detachment, with 1 Trestle bridge waggon; sick transport waggon.

(Signed) v. BUDRITZKI,
Lieutenant-General Commanding 2nd
Infantry Division.

The outposts of the west division were posted as follows in front of the Schöppengraben: at Ceestow and at Dyrotz one company of Jägers each, supported by two battalions of the Fusilier regiment behind the latter place. At Priort was a third Jäger company, and at Carpzow a battalion of the Fusilier regiment in support. Another company of Jägers was at Klein-Paaren, and a subdivision of Hussars was pushed forward to Satzkorn.

Owing to the nature of the ground, the advancing columns of the east division could not be seen, but by the positions of their guns upon opening fire and by the clouds of dust which arose wherever the troops were in movement, the general dispositions of its commander could be fairly divined, and the commander of the west division took his measures accordingly. Leaving only one regiment in Wustermark, he concentrated the greater portion of his forces on the Mühlenberg behind Buchow, sending the Uhlan brigade with two battalions of infantry and a horse battery to Falkenrehde.

Column No. 2 was the first to come into contact with the outposts of the west division, which it did at Priort, driving them back upon the battalion in support, which was stationed in the wood on the left front of Carpzow, supported by a battery on its left. The fire of this was shortly afterwards answered by two batteries from the Eichberg, which supported the infantry's advance. The latter pressed close upon the retiring Jägers, but on cresting hill (128) it was received by a heavy fire from the wood, which caused it to pause and correct its formation. The Emperor Francis Joseph's regiment was in front, and the new formation was adopted to its fullest extent, for the three first lines were all extended, being supported by the remainder of the battalions in company-columns. The ground was remarkably favourable for this formation, as the approach was over an undulation sloping towards the enemy at only a couple of hundred paces distance, which enabled all the lines to fire during their advance, which was done without even pausing. From about 50 paces the ground rose again towards the wood, and on this, about 40 paces distant, the first line lay down, being successively reinforced by the second and third, and still more by the extension of sections here and there from the supporting companies, and a very rapid independent fire was opened. During this time a company was advanced by the left flank in file, so as to take the enemy in flank and rear. The enemy eventually fell back, after an enormous expenditure of ammunition, to Buchow, and the village of Carpzow was entirely evacuated, and occupied in force by column No. 2. The main body, however, accompanied by the artillery was directed by the heights north of the village against the Mühlenberg, between which and Buchow the enemy's artillery was posted. All attempts however to throw a bridge over the stream were unsuccessful. In the mean time a periodical fire was kept up along the whole line of the stream without any decisive effects, except that the passage could not be effected. A battery belonging to the advance guard of the west division kept up a steady fire from a very favourable position on the Fichtenburg until driven back by musketry fire. In this position the centre remained for upwards of an hour from before 10.30 to 11.30 o'clock, the east division attempting to effect a passage, but being frustrated on every occasion by the vigilance of the opponent on the other side of the stream.

In the meanwhile the cavalry of the first column having debouched from the wood in front of Dyrotz, was received by a heavy fire and forced to fall back precipitately behind some sheltering ground. Shortly afterwards the infantry debouched also, and advancing in extended order, succeeded in bringing the 6th heavy battery into position. It was, however, impossible to maintain it on account of a heavy musketry fire from a subdivision of Fusiliers, and the battery was forced to fall back. On the advance of the infantry, however, the subdivision retired, but in spite of every endeavour it was not able to dislodge the infantry of the east division, which had partially intrenched itself, shortly before 11 o'clock, though the latter and to fall back to take the place of the 2nd regiment, which had been drawn off to the centre, at the Wustermark, where it maintained the line of the Schöppengraben until the order was received at 12 o'clock to relinquish the position.

At about the time that the action came to a stand in the centre and left, the third column approached Klein-Paaren. The dragoon brigade after passing through Satzkorn, arrived at the passage over the Wublitz marsh west of Klein-Paaren, and obtained possession of it. As, however, the bridge was supposed to have been destroyed, half an hour was fixed by the umpire for its re-establishment. In the meantime reinforcements from the west division enabled its advanced posts to resume the offensive and regain possession of the passage. The village of Falkenrehde was now strongly occupied by the 3rd regiment of Foot Guards, whilst the horse-battery opened fire upon Klein-Paaren.

The infantry of the third column marching by Kartzow had found it impossible to establish a bridge there, on account of the marshy nature of the ground, and was therefore considerably delayed. On the arrival of its advanced guard however, the bridge was again regained, and two companies followed the retreating enemy. These were attacked by the united Uhlan brigade, which came upon them from three sides, and the umpire's decision was against them. The main body of the column now began to debouch, followed by the Dragoon brigade, but the whole had to retire on account of the success of the Lancers.

A second advance against Falkenrehde failed on account of the heavy musketry fire of the troops occupying it, and only after considerable preparation by the fire of three batteries massed north of Klein-Paaren was a third and final attack undertaken. The infantry of the west division now evacuated Falkenrehde and fell back upon Buchow, the horse artillery taking up a position at point 171, where it was supported by the Uhlan brigade, which was in rear sheltered by a slight dip in the ground. The cavalry of the east division now advanced to the west of Falkenrehde, and formed up in two lines ready to meet the Uhlan brigade. It was forced to retire however by the artillery fire, and was followed by the Uhlans, but without coming in contact.

In the meantime some detachments of the second column had succeeded in effecting the passage of the stream and had obtained a footing in the wooded ground at the foot of the Mühlenberg. In consequence of this, and also on account of the time fixed for the holding of the position having almost expired, the Commander of the west division relinquished his hold upon Buchow, and retreated towards Etzin. As it happened, this was done at exactly the right time, for had he maintained his position, his line of retreat would have been most seriously menaced by the advance of the enemy on his right flank, of which he was not at the time aware. At the same time the extreme left fell back by Tremmen on the way to Brandenburg.

The cavalry of the east division advanced close up to the Weinberg, but received a heavy fire from the battery posted there. The Cuirassier brigade was then attacked by the Uhlans but without effect, until taken in flank by the Hussar regiment which had been carefully brought up on the right, sheltered by a slight undulation in the ground. The east cavalry, however, presently advanced again, accompanied by a battery which forced that of the enemy to retreat. The Uhlan brigade protecting this movement was brought to a stand and forced to receive a charge of the Cuirassier brigade, which caused it to fall back. It still showed a front however, until it joined the infantry on and to the right of the road to Etzin. Here a final attempt was made close to the Hebensberg to deter the enemy's retreat, but the infantry, forming battalion-squares, opened such a tremendous fire that a further advance was impossible, and the west division continued its retreat covered by a battalion and a battery on the Belvedere and the cavalry in the plain. At this moment the " halt " was sounded, and the movements were discontinued.

Comments.

The first subject for remark in both these manœuvres is the turning movement, as naturally employed now by German tacticians as the line-formation has hitherto been by ourselves. Success is always a favourable plea, and this movement has undoubtedly been successful beyond measure during the more modern campaigns, and I am afraid that this has been the means of leading us to favour it more strongly than it deserves. We are told by high military authority that a flank-attack should not be attempted except by a superior force, and I think that late experience has strongly confirmed this view. On every occasion almost, with the exception of Trautenau, in 1866, these turning movements, which lead necessarily to a very considerable extension of front, have been made with superior forces, and on this one exception the appearance of a regiment unexpectedly on the flank, caused the retreat of the whole line. With the examples we have before us, we may know pretty surely that these are the tactics likely to be employed against us, and that as we shall presumably be oftener on the weaker side, our task is rather to study how to meet these attacks than to practise such extended movements ourselves. Now that the defensive power of artillery is so much increased, this arm is able in a great degree to fill up intervals between bodies of infantry, as was done by the Corps artillery in the corps manœuvre acting between the first and second divisions, and thus takes the place of the bodies of cavalry formerly employed. This facilitates considerably the extension of infantry, and secures it up to a certain point, but beyond this it cannot be extended without danger. In the case before us the attacking front extended at one time from Seeburg on the left to Closterfelde on the right, a distance of 6,500 paces, one half of which was occupied only by the left-flank-detachment and by the cavalry division supported by two batteries, which might have been easily kept in check by the retention of Seeburg by a sufficient force, without materially weakening the main position or endangering the line of retreat. By this means also the heights already in possession of the enemy could have been flanked by artillery fire. The subsequent manœuvre is a still more striking case: here the attacking front was no less than 12,000 paces in extent, and nearly the whole of this defended naturally by impassable ground. No attempt, as it happens was made by the defending force to meet the turning movement on its right, probably because of its numerical inferiority; but the easy retention of the first and second columns of the left, warrant us in supposing that had the main body of the west division been carried to Falkenrehde, and fallen upon column No. 3 after the latter had crossed the Wublitz-Graben, the result would have been disastrous. On this point, I think we may at least conclude that, should the defender be fully informed of his opponent's movements, as he ought to be, he need never fear being outflanked unless he be the victim of a very considerable numerical inferiority. Otherwise he has only to follow the example set him, extending with his opponent, and seizing the moment he judges most opportune for a vigorous stroke upon his weakened line.

Infantry.

In the action of the artillery we notice the system of combined movements of masses developed to its greatest extent. The artillery divided into certain parts, according to the formation of the columns, is never subdivided, except perhaps for momentary action, and is always in front, preparing for the advance and final blow, as it were, which can now only be dealt by infantry as an auxiliary implement after the way has been thoroughly prepared for it. Following rapidly each retrograde movement of the enemy, it loses no time in preparing for a further attack, closing in as the enemy's threatened flank is withdrawn, until every gun is brought to bear effectively on the final position. When once this period is arrived at, patience alone is required to allow the enemy to be completely crushed, in spirit as in body, before launching the combined and final attack. The former strength of the artillery attached to a corps, which was 12 foot and 3 horse batteries, was considered insufficient to carry out this work effectually, and has been increased by two foot batteries; and no movement of the united corps is considered complete unless every gun is in action. It is remarkable that such implicit confidence should be placed in the artillery now as to employ it in lieu of infantry, for it is only since the campaign of 1866 that it has been considered safe to venture it away from infantry at all. Now, few German artillerists will allow that guns can be in any possible danger, whatever their position, unless attacked unawares. We can hardly adopt this as a maxim, however, for the experience of the Germans has been rather one-sided, unless we take the evidence of the campaign of 1866, in which case we see that the Austrian artillery, which was certainly then far superior to theirs, and is so, I consider, still, was not able to hold its own against infantry in extended order, and I do not think any artillery can.

Cavalry.

The collecting of the whole of the cavalry, with the exception of regiments attached to divisions or columns, into brigades worked together on the extreme flank, shows an appreciation of the true employment of cavalry in line. To recall the whole of the advanced chain which has been feeling the way of the army, and to form it into a coherent mass, is one of the first cares for a Commander on coming into contact with the enemy. There are only two flanks, and the one is sure to claim advantages for the action of cavalry over the other, and when once this is determined, it becomes the business of the cavalry Commander to keep his force as far as possible out of fire and to launch it when a favourable moment arrives. In the manœuvre of the 10th, great expertness was shown in the movements of the cavalry masses, and the taking of the Cuirassiers in flank by the Hussars from a sheltering fold of ground at the commencement of the retreat was superb, but the subsequent movements of the cavalry of the east division showed a disregard for both artillery and small-arm-fire which must have been fatal to it. It may be argued that it was acting upon the supposition that the retreating force must be demoralized. The retreat, on the contrary, was conducted with the greatest order and steadiness. Assimilation to real war is a sufficiently hard task when only the results of actual movements, attacks, &c., have to be taken into consideration in a material point of view, but if the morale is to enter also into the calculations, it becomes impossible. Again, were even this to be considered, it would have told more severely upon the cavalry itself, for experience has shown us that a body of cavalry which has once charged well home, is not fitted for further employment for a considerable time, whereas in the present case four charges were given in quick succession, and the cavalry was all the time under artillery, and latterly under small-arm-fire as well.

Infantry.

The adoption of some modified formation for the attack of exposed positions by infantry, has been a question for some years past, and one which has not yet been definitely decided. The various evidence relating to the last war has, however, been sifted, and a formation suggested as likely to meet the requirements of the present day. It was found during the war, and especially in very open ground, that a speedy reinforcement was required for the extended line, and the supports in close order in rear had to be broken into, in order to supply it. This caused very considerable delay, and a great deal of confusion, as must necessarily be the case; and the formation proposed to remedy these defects provides for a second extended line, which can reinforce the front one as required. This can be extended to any degree by having a third, or even a fourth line in skirmishing order, and the former we have seen was employed by the Emperor Francis Joseph's regiment for the attack on the Carpzow wood. These are followed by the supports in close order, in whatever formation is suitable to the ground, and the remainder of the battalion follows, generally in half battalion formation. The advance is executed by a series of rapid movements to the front, and then a rest, the whole lying down, as was adopted by one division of this same corps in the attack upon le Bourget. In perfectly open ground such a formation is undoubtedly suitable, providing as it does for the gradual reinforcement of the foremost line, it allows the supports to keep further to the rear, and to move out of their positions if necessary, in order to take advantage of any neighbouring cover. Where the ground also is at all sloping towards the enemy's position, it provides two tiers of fire, the second line firing over the heads of the first. In wooded or broken ground, however, I do not think it would be possible to maintain these lines distinct for any length of time, and the men destined for ultimate reinforcement would crowd the foremost line long before they were required. The method of advancing rapidly and lying down at intervals is very good in open ground, but if perfectly free from undulations, which is rarely the case, I should not consider it expedient to stop again after arriving within 200 paces of the position. A careful and rapid fire of considerable duration from the last pausing-place, and then the final rush, would, I think, be a greater economy of men than three more halts, which there would be if these were made at about every 50 paces. Some such formation as the above is undoubtedly required to be practised, and some similar method of attack, but the occasions for their use should be left entirely to the discretion of Officers in command of companies, to whom too great latitude cannot be allowed in these matters. In the thorough training of these Officers in a knowledge of ground by means of theoretical study, by maps, and constant practice in varied ground in the field, lies the first earnest of success in the attack of a position by infantry.

In conclusion, I would venture to point out one other circumstance to be remarked in these Manœuvres. I have already mentioned that the cavalry exposed itself considerably to the fire both of artillery and of infantry in what appeared an unwarrantable manner, but this seems to have been done on principle. With the infantry, however, it is different; no German Officer probably can be found who would advocate the old plan of a steady advance without regard to cover or the enemy's bullets, and yet such advances were made only too often. A disregard of fire and of cover, which could vie with that of our most strictly parade-drilled troops was displayed on several occasions. The fire also was most hurried, and a want of care in the aim taken, told little for the "fire discipline," of which we have read and heard so much. This was accounted for in the following manner; in order to suit the time of the visit of the Emperors to Berlin, these greater manœuvres were being executed before the lesser ones with mixed arms had been carried out, instead of after them as should have been the case. This, in the eyes of the German Officers, fully accounted for unsteadiness, and they regretted that it should have been done even in such an exceptional case. That this view is correct there can be little doubt. With troops which manœuvre together yearly, the preliminary tactical training cannot be dispensed with; we may easily therefore draw the inference I think, that it can be much less dispensed with with troops which are brought together for the first time on the eve of operations on an extensive scale.

A BRIEF SKETCH OF THE SYSTEM OF OFFICERING THE PRUSSIAN ARMY.

By Lieut. CHARLES E. H. VINCENT, 23rd Royal Welsh Fusiliers.*

Modes of Entering the Army.

THERE are two ways by which, in time of peace, a Prussian Officer can obtain his first commission:—

(*a.*) By passing the required examination in general subjects, serving a short time in the ranks, and afterwards as a Non-commissioned Officer, and qualifying in the theoretical knowledge of his profession, after a nine months' course of study at the School of War.

(*b.*) By passing this latter examination direct from a special superior class of the corps of cadets.

The *modus operandi* in case (*a*) is as follows:—

The aspirant to a commission in the Army presents himself to the Colonel of the regiment to which he hopes eventually to belong. Should his birth be such as to render him a suitable comrade for the Officers of the regiment, and his parents be prepared to provide sufficient means for him to live on the same standard of expenditure as his brother Officers, and should his testimonials as to conduct and character be satisfactory, the Colonel gives his consent to his coming into the regiment, provided the medical inspection puts no obstacle in the way, and the candidate pass the "Fähnrich's" ("Ensign" he can't be called, for "Ensign" in our Army means a Commissioned Officer, on one roster with the Lieutenants, corresponding to the second Lieutenant of the Prussian service) examination in general subjects—such as French, English, geography, history, Latin, Greek, mathematics, and drawing—which is held periodically under the auspices of the Government. This examination passed, the "Fähnrich" provides himself with the uniform of a private soldier, though made of better cloth, and he is allowed to wear his sword-bayonet in the streets, &c., with an Officer's sword-knot attached thereto. He joins the regiment, is attached to a company, and is drilled in every respect as a common soldier. In some regiments he must live for a week in the barrack-room; but as a general rule he is allowed a room to himself during the entire time. He is made an honorary member of the Officer's mess (though never omitting to pay his superiors every mark of military respect), in order that they may have additional facility for observing the character of their future comrade.

As regards absence from barracks, the "Fähnrich" is bound by the same restrictions as the private soldier, if he be serving in the ranks, or as the Non-commissioned Officer, if he be doing duty as such. His morals are under the care of his Captain; and the Colonel, knowing exactly the funds he commands, can judge if his habits of life are beyond the length of his purse. The "Fähnrich" receives the pay of the rank with which he is doing duty.

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* Reprinted from a pamphlet circulated privately in January, 1871.

Having thoroughly mastered every detail of his drill and duty as a private, he is passed through the several grades of the non-commissioned ranks. He must perform *every* duty *at least* once himself, after which he may pay a substitute. The "Fahnrich" is then sent on to the School of War (Krieg's Schule), organized on much the same principle as our military academies, in companies with professors, superintendents of military discipline, and student under Officers and Corporals. Here during a course of nine months, working nine or ten hours a day, he is taught the theory of war, fortification, military history, surveying, &c., &c., but beyond riding-classes there is no military drill. For the slightest offence, whether of idleness or of conduct, the "Fähnrich" returns for a year to the ranks of his regiment, thus losing a year of his career. The severity of the discipline at the Krieg's Schule passes all comprehension; a minute late, an illicit correspondence, and the merest infraction of the letter of the law, is followed by the severest punishment. Should the "Fähnrich" be suffering on entering from venereal disease, he returns forthwith to his regiment, and in like manner if he contracts it during his residence at the institution. At the end of nine months the examination is held; those that pass, return to their regiments to await a vacancy in the subaltern ranks, and, although retaining the old uniform, wear an Officer's sword; those that fail, are not allowed another trial. The "Fähnrich" who has passed the School of War, does duty as a second Lieutenant, and a vacancy occurring, the Colonel assembles the Officers, and inquires if they have any objection to accept him (the "Fähnrich") as a comrade. Should he have made himself in any way obnoxious, or should be have proved himself an unworthy companion, one who would never be to the credit of the regiment, the Colonel would recommend him for his commission, but append thereto a request that he shall be transferred to another regiment on obtaining his promotion. The transfer he may also obtain at his own request; but should all be well, he will obtain his commission forthwith in the regiment.

(*b.*) A cadet first enters the corps at the age of ten, but beyond an hour's drill or gymnastics daily, except in the higher classes, the education differs very slightly from that of an ordinary public school. Beyond the first class, is a special military class, in which the same subjects are taught as at the School of War, and from which the Officer's examination may be directly passed. But if the cadet leave the corps before he reaches this class, his military route differs in no way from that of the private individual, and even those who pass from the special class have to learn practically the duties of a soldier and Non-Commissioned Officer. Commanding Officers, as a rule, prefer those Officers who have not been cadets, as their education and line of life has extended over a wider scope, and also because the discipline of the cadets having been so terribly severe, they generally break away when the curb is loosened. The only exceptions for Fähnrichs not passing the School of War is in favour of those who have passed the

"Abiturienten" examination (the Bacchélaureat of France, the Degree of England), or who have resided for a year at a university.

Instruction of Officers.

The Officer, when once he has obtained his commission, is freed from all further theoretical instruction, but in garrisons, voluntary classes are formed. Each year every Prussian Officer under field rank has assigned to him a practical and a theoretical task.

The practical task is as follows:—The Officer is warned over night that on the morrow he will have to carry out his practical exercise, for which purpose he will be on parade at such an hour. Here he finds the detachment awaiting him which is to be at his orders. Sealed instructions are handed to him, on which he forthwith acts. But an hour before, another Officer has left the barracks to carry out also his practical task, with instructions, the reverse of those of his unknown opponent.

For instance, one Officer is informed that his party forms the advanced guard of a force attacking Berlin from the north; his directions are to feel well forward for the enemy, to find the best position for crossing the river, and, if necessary, to force a passage. His opponent has the command of the advanced posts of the defenders, and makes his dispositions accordingly. The parties are distinguished by the one wearing forage caps and shell jackets, and the other wearing full dress, and in the cavalry with lance-flags furled, and flying. At the time when a critic may be able to form an opinion on the superiority of the one's disposition over the other's, the Colonel, General, or some other superior Officer comes up, and decides for the victor. Both parties then unite, and publicly each Officer explains his dispositions, and the reasons for making them. The Colonel, or umpire, makes his remarks and awards praise or blame. It is obvious that as the whole matter goes before the superior authorities, and every Officer is anxious to appear to advantage in the eyes of the men, a spirit of emulation is excited, and as all the details are patiently explained to the men, they too take an interest in the result. The contending Officers, on their return home, draw up a complete military report of the proceedings, with a sketch.

The theoretical task is one which is awarded to each Officer yearly, and to perform which he is allowed a time in proportion to the subject.

The subjects are infinite: invasion of different countries; army organisation, sanitary and commissariat arrangements in the field; training horses, &c., &c.; in which full freedom and liberty of speech are allowed; and, however wide the work may be from the mark, it must accomplish its purpose of developing habits of thought and study. The task when completed is read by the Colonel,—the Generals of Brigade and Division each appending his remarks,—and is then returned to the author. Those of special excellence go before yet higher authorities, and even to the Emperor himself.

Examination for Promotion.

There is none for any commissioned rank in the Army.

Relative Merit of Officers.

The relative merit of every Officer, from highest to lowest, is known to the general staff at Berlin. Each year a confidential report is made by the Colonel of the regiment and the General of Brigade, on every Officer under their command; that of subalterns is based on the testimony of their Captains. Extracts from these reports are entered at head quarters in a "Conduitten Liste." On the commencement of a campaign, those Captains whose military proficiency is of an inferior order, are left behind with the Reserve, or speedily disposed of as commanders of an unimportant post. The same principle works from General to junior second Lieutenant. Those of ability are pushed on; those of inferiority kept in the background. In every regiment there is one Major, but should he be unfit to assume the command of a regiment he is passed over "*sans mot dire.*" The Majors of the Army are on one list for promotion, whereas the promotion of the junior Officers goes regimentally. Now, a Major seeing one junior after another get the command of a regiment, speedily appreciates his incompetence, and retires. Thus the quality of the Colonels and Generals is accounted for.

Promotion for Merit in Peace.

An Officer who shows marked ability in any particular subject or line, is pushed on very rapidly by the following means. His commission as second Lieutenant bears date August 10th, 1869; he is drafted into a regiment, where the senior second Lieutenant would be his junior; he therefore takes his place at the top of the list, and obtains the first vacancy for promotion, and so on again.

Staff or Regimental Employment.

Except in special cases, which are by no means rare, Officers are not eligible for staff or regimental employment until they have had three years' service.

Staff College,

the equivalent for which is the "Krieg's Acadamie," to enter which an Officer can try after three years' service. The course of study is three years. At the end of each year, should an Officer not come up to the standard, he will return to his regiment, by no means injured in reputation, but rather with a character for a desire to improve. Those who pass, are sure of staff employment, each according to his line. It is needless to add, that visiting privately the defences, lines of invasion, &c., of foreign countries,—however peaceful the existing relations,—finds employment for considerable numbers.

Leave of Absence.

Each Prussian Officer receives, as a rule, from six weeks to two months' leave of absence during the year—*i.e.*, about a fortnight between the winter and spring-drills, about three weeks in the middle of summer, between the spring-drills and summer-manœuvres, and about a fortnight between the summer-manœuvres and the winter-drills. Of course never more than half the Officers are absent at one time, and if an Officer desire, for some well substantiated reason, to have the whole at once, or the accumulation of two or three years, he can do so.

Pay, Regimental Details.

Each Officer receives his pay direct from the Paymaster, with monthly deductions for messing, tailors', shoemakers' bills, widows' fund, band, &c., &c.; and there are also many regimental details in points of honour, etiquette, &c.; many regimental committees, so perfectly incompatible with the British service, that I refrain from entering into them, but only add, that as the Colonel knows the income of each of his Officers, he can check any undue expenditure.

Connection with Men.

The connection of the Prussian Officer with his men is very close. He drills them, gives lectures to them, superintends their every action; an Officer during the winter months gives lectures to them on their profession, on geography, military history, &c., to which classes the voluntary attendance is very large. In fact, the Officer is constantly showing how thoroughly he is the master of his profession, and by education, birth. and breeding, the superior of the soldier.

Social Position of Officers.

In the Guards, the majority are of noble families, but in the Line many are gentlemen only by virtue of their cloth and education; but so high is the standard of honour among them, that I recently heard a very animated discussion as to whether it was consistent with the dignity of an Officer to take a rifle from a private in action for the purpose of killing, by superior skill, one of the enemy whose death would be of importance. Some argued that it was the duty of every Officer to inflict as much injury as possible on the enemy, and being a better shot, he would be to blame if he did not adopt the above-named course. However, a very large majority decided that it would be a breach of international honour and etiquette to depart thus from your position as an Officer.

The Journal

OF THE

Royal United Service Institution.

Vol. XVI. 1873. Appendix.

PROCEEDINGS OF THE FORTY-SECOND ANNIVERSARY MEETING.

The Forty-second Anniversary Meeting of the Members was held in the Theatre of the Institution, on Saturday, the 1st March, 1873.

The Most Hon. the Marquis of Lansdowne, Under Secretary of State for War, in the Chair.

I. The Secretary read the Notice convening the Meeting.

II. The Secretary read the Minutes of the Forty-first Anniversary Meeting.

III. The Annual Report of the Council was read as follows:—

1. The Council have much pleasure in laying before the Members their Forty-second Annual Report.

Members.

2. The number of Members who joined the Institution during the year 1872, is three hundred and thirty-six, being an increase of ninety-nine over the number of the previous year. The loss by death is one hundred and four; and thirty-eight Members withdrew their names. The net increase in the number of Members is, therefore, one hundred and ninety-four.

A detailed statement of the changes in the list of Members, and a tabular analysis of the past and present state of the Institution, will be found on pages ix and x.

Finance.

3. The usual Abstract of the Yearly Accounts, as audited on the 11th February, will be found on the following page.

GENERAL ABSTRACT OF THE ACCOUNTS OF THE ROYAL UNITED SERVICE INSTITUTION,
FROM 1st JANUARY to 31st DECEMBER, 1872.

EXPENDITURE.

	£	s.	d.	£	s.	d.
Secretary's Salary	250	–	–			
Ditto Lodging Allowance	50	–	–			
				300	–	–
Librarian's Salary...				150	–	–
Acting Clerk's Salary				70	4	–
Servants' Wages				431	19	2
Ditto Clothing...				46	2	–
Insurance...				11	5	–
Ground Rent				200	7	3
Fuel				51	19	–
Lighting				47	8	3
Annuity to John Pitt				20	–	–
Assessed and Income Taxes...				69	15	7
Parish and Water Rates				100	–	8
Artificers				108	5	3
Museum				153	3	3
Library, Reading, and Topographical Rooms				191	12	5
Advertisements				133	17	2
Printing Circulars and Stationery				218	9	10
Lectures				28	6	–
Journals, including Annual Report and List of Members				974	12	10
Postage { Journals	131	16	2			
Postage { Letters...	52	4	10			
				184	1	–
House Expenses and Sundries				50	18	10
Cash repaid to Agents				12	10	–
Charges from ditto				–	12	2
For £365 16*s.* 4*d.* India 5 per cent. Stock				400	–	–
Balance (Income) { Bill at 90 days due 16th Feb. ...	11	–	–			
Balance (Income) { At Bankers	144	8	–			
				155	8	–
				£4,110	17	8
For £812 10*s.* 10*d.* 3 per cent. Consols, Life Subscriptions				750	–	–
Balance (Life) { Bill at 90 days due 16th Feb. ...	27	–	–			
Balance (Life) { At Bankers	86	10	–			
				113	10	–
Total Income and Life				£4,974	7	8

RECEIPTS.

	£	s.	d.	£	s	d.
Balance at Bankers, 31st December, 1871				156	6	1
Annual Subscriptions, at 10*s.*	359	–	–			
,, ,, above 10*s.*	2,172	19	6			
,, ,, arrears	71	10	–			
,, ,, advance	10	1	–			
Increased Subscriptions, at 10*s.*	7	–	–			
				2,620	10	6
Entrance Fees				336	3	–
Donations				2	12	–
Dividends				264	10	1
Interest on Exchequer Bills				20	7	2
Government Grant				600	–	–
Sale of Journals				100	18	8
Miscellaneous Receipts				9	10	2
				£4,110	17	8
Balance of Life Subscriptions at Bankers, 31st December, 1871 ...				150	10	–
Life Subscriptions				713	–	–
Total Income and Life				£4,974	7	8

Examined and found correct, 11th February, 1872.

J. E. A. DOLBY }
TOB. G. RIDGWAY } Auditors.

T. D. SULLIVAN, Accountant.

Estimate of Receipts and Expenditure for the Year 1873.

Expenditure.	£	s.	d.
Secretary's Salary and Lodging allowance	350	–	–
Librarian and Accountant's do.	200	–	–
Acting Clerk's do. ..	70	–	–
Servants' Wages	450	–	–
Ditto Clothing ..	50	–	–
Insurance	11	5	–
Ground Rent	205	–	–
Fuel	100	–	–
Lighting	60	–	–
Annuity to John Pitt ..	20	–	–
Assessed Taxes & Income Tax	100	–	–
Parish and Water Rates	110	–	–
Artificers, Repairs, &c. ..	150	–	–
Museum	200	–	–
Library and Topographical Departments	200	–	–
Advertisements	150	–	–
Printing Circulars, & Stationery	150	–	–
Lectures	50	–	–
Journals	1,000	–	–
Postage of Journals ..	170	–	–
Postage	60	–	–
Printing Annual Report and List of Members ..	80	–	–
Miscellaneous	60	–	–
Balance ..	351	15	–
Total.. ..	£4,348	–	–

Receipts.	£	s.	d.	£	s.	d.
Balance at Bankers, 31st Dec., 1872				263	–	–
Annual Subscriptions :-						
At 10s. ..	350	–	–			
Above ..	2,500	–	–	2,850	–	–
Entrance Fees				250	–	–
Dividends				280	–	–
Sale of Journals				100	–	–
Government Grant ..				600	–	–
Total.. ..				£4,348	–	–

The Council have increased the Salaries of the Secretary and Librarian by £50 each.

Life Subscriptions.

4. Life Subscriptions amounting to £750, including £150 10*s*., not invested last year, have been invested in Three per Cent. Consols.

Capital Account.

5. The funded property of the Institution on the 1st January, 1873, was £8,926 12*s*. 4*d*., as compared with £7,748 7*s*. 2*d*. on the 1st January, 1872.

TENURE OF THE PREMISES.

6. In the last Annual Report, the Members were informed by the Council that they were making inquiries with regard to building sites in this neighbourhood, and likewise as to the cost of a building suitable to the purposes of the Institution.

In making these inquiries, the Council were assisted by the late Mr. Marrable, an architect highly recommended, and well acquainted with this part of London. No suitable site could be found at a lower price than about £21,000; adding the cost of a new building and the necessary expenses of moving, fittings, &c., the total expense of placing the Institution in proper working order in a new position, cannot be estimated at less than £37,000.

On June 13th, a letter was written to the Chancellor of the Exchequer reminding him of his promise to help the Institution when the proper time arrived, and stating the large expenditure which must be incurred to establish the Institution in a suitable position, should its removal be insisted on by the Government.

In reply, a letter dated September 30th, was received from the Lords of the Treasury, withdrawing the notice to quit in April, 1873, and allowing the Institution to retain these premises "on the terms of the existing arrangement."

With the hope of obtaining some definite information as to the future disposal of the Crown-lands in this neighbourhood, a deputation of the Council had an interview on November the 23rd with Mr. Gore, First Commissioner of Woods, &c., who informed them that the whole question depended upon the course that might be taken by the House of Commons with regard to a strip of land on the Embankment, respecting which difficulties had arisen between the Metropolitan Board of Works and the Government; and that until the ownership of the ground had been decided, the Government could make no definite arrangement as to the future.

LECTURES AND JOURNAL.

7. In addition to the ordinary Lectures and Evening Meetings last year, the Council granted the use of the Theatre to the Officers of the Rifle Volunteer Corps for five Special Lectures. These Lectures were so well attended that the Council have approved of two courses of Special Lectures being given during this year; one course to the Rifle Volunteer Officers, and the other to the Officers of the Volunteer Artillery.

The thanks of the Council are eminently due to all who gave lectures or read papers during the last session in the Lecture Theatre, where questions of the highest importance were considered and discussed, previous to publication in the Journal. Since the prosperity of the Institution depends in a great measure on the estimation in which the Journal is held, it is satisfactory to find kindred Institutions, both at home and abroad, desirous of an interchange of publications; and the marked increase of new Members may fairly be attributed to the Journal having become more widely known and better appreciated among the Officers of the two Services.

LIBRARY.

8. Four hundred and seventy volumes were added to the Library during the past year; of these, 209 were purchased and 263 presented. Among the latter, the following are the most noteworthy:—

By the AUSTRIAN Government—
Mittheilungen über Gegenstände des Artillerie- und Genie- Wesens.

By the FRENCH Government—
Revue Maritime et Coloniale.
Six Volumes on Military and Naval subjects.

By the ITALIAN Government—
Rivista Militare.
Rivista Marittima.

By the NETHERLANDS Government—
Six Plates of Artillery Equipment.
Twenty Volumes on Military subjects.

By the PRUSSIAN Government—
Archiv für die Artillerie- und Ingenieur- Offiziere des Deutschen Reichsheeres.
Militärische Blätter.
Militair- Literatur- Zeitung.

By the RUSSIAN Government—
Engineering Journal.

By the SPANISH Government—
Memorial de Ingenieros.
Thirteen Volumes on Military subjects.

By the SWISS Government—
Fifteen Pamphlets on Military subjects.

By the UNITED STATES Government—
Seven Volumes on Military and Naval subjects.

The exchange of Journals with Foreign Governments, and with various Scientific Societies in this, and other Countries, has been continued. Three hundred and ten Volumes of duplicate books were either presented to other Societies or sold.

The Library now contains 15,761 volumes.

TOPOGRAPHICAL DEPARTMENT.

9. The Secretary of State for War has presented Photographs and Lithographs of Guns, Casemates, Shields, Targets, &c.

The Institution has also received from the Lords Commissioners of the Admiralty, Charts, Sailing-Directions, &c.

The French Government have presented some Maps, &c.

Museum.

10. The importance of the Kriegsspiel as a means of military education having been recognized in this country, the Council procured from Berlin, through the kindness of General Walker, C.B., Military Attaché there, sets of the Kriegsspiel and of the Festungs Kriegsspiel. The former game has created much interest amongst the Members, and has been played in the Theatre of the Institution. It has now been generally introduced into the Service.

Amongst the additions to the Museum, the following may be noted, viz.:—

Topographical Model Room.—An elaborate Model of Paris, with the German lines of investment, by Herr Walger, of Berlin. Horizontal scale of model, $\frac{1}{80,000}$, vertical scale, $\frac{1}{8000}$.

Naval Model Room.—Half-block Models of H.M. Ships "Raleigh," "Hotspur," "Cyclops," and "Snake," made by permission of the Lords of the Admiralty, in H.M.'s Dockyards, at the cost of the Institution.

Gun-Model Room.—Models (quarter-size) of the 35-ton Gun, 8-in. Howitzer, and 9-pr. M.L. Field Gun, with their respective Shot and Shell.

Armoury.—Sword of Honour, voted by the Patriotic Fund at Lloyd's to T. Pendergras, Esq., commanding the H.E.I. Company's ship "Hope," one of the fleet which, on the 15th February, 1804, drove off a squadron of French men-of-war under command of Admiral Linois, in the "Marengo" of 84 guns, as recorded in the "London Gazette" of August 11th, 1804. This sword was presented to the Museum by Major J. G. Clarke, late 68th Light Infantry, a Member of the Institution.

The thanks of the Council have been tendered to the Secretaries of State for War and for India, to the Lords Commissioners of the Admiralty, and to the several donors for their respective contributions.

Vice-Patrons.

11. The Council have to record the deaths of the following Vice-Patrons, viz.: Admiral of the Fleet Sir Thomas J. Cochrane, G.C.B., and Field Marshal Sir George Pollock, Bart., G.C.B., G.C.S.I., Constable of the Tower.

Sir Thomas Cochrane entered the Navy in 1796, and saw active service on various stations up to June, 1805, when he was promoted to the command of the "Nimrod," sloop of war. In 1809, when in command of the "Jason," he captured "La Favorite," French national ship, and assisted in reducing the Danish West India Islands. In the same year Captain Cochrane served at the capture of Martinique and the Saintes, and was present at the operations in the Chesapeake and on the Coast of Georgia. In 1824, he was nominated Governor and Commander-in-Chief of the Colony of Newfoundland, which command he retained till 1834. In 1842, he hoisted his flag in the "Agincourt," as second in command on the East Indies and China

Station, where from 1845 to 1847 he filled the post of Commander-in-Chief; in the latter year he was created a K.C.B. Sir Thomas Cochrane became a Vice-Admiral in 1850, and was Commander-in-Chief at Portsmouth from 1852 to 1856, in which year he attained the rank of Admiral. In 1860, he was created a G.C.B., and in 1865 was appointed Admiral of the Fleet.

Sir Thomas Cochrane joined the Institution in 1832, and was elected a Vice-Patron in 1863.

Field Marshal Sir George Pollock, Bart., G.C.B., G.C.S.I., Constable of the Tower.

Sir George Pollock entered the Military Service of the East India Company in 1803 when scarcely eighteen years of age; was present at the storm and capture of Dieg in 1804; at the gallant but unsuccessful attempt to carry Bhurtpore by assault in 1805; and at the close of that year commanded the Artillery with Colonel Ball's detachment, sent in pursuit of Holkar. In 1816, he commanded the Artillery with General Wood's force in the Nepaulese War. In 1824, having attained the rank of Lieutenant-Colonel, he was nominated to command the Bengal Artillery attached to the force under Sir Archibald Campbell, proceeding to Rangoon, and for his services in that campaign was nominated a Companion of the Bath. In 1841, having attained the rank of Major-General, he was selected by the late Sir Jasper Nicolls to take command of the troops proceeding to Peshawur, in the hopes of recovering our position in Affghanistan. An immediate advance on Jellalabad to relieve Sir Robert Sale and the British Force shut up there being found impossible, General Pollock and his troops were forced to remain inactive in the neighbourhood of the Khyber Pass until the end of March, 1842. Having forced the pass by a series of brilliant and skilful operations, Sir George Pollock marched to the relief of Sir Robert Sale and his intrepid garrison, defeated the Affghan Forces and entered Cabul on the 17th September. General Pollock having been joined by General Nott, led the united army safely back to India, through those formidable passes which had so long delayed his progress. For these brilliant services, he was rewarded by being nominated a Grand Cross of the Bath, and was presented with a valuable sword by Shere Sing, ruler of the Punjaub. Sir George Pollock also received the thanks of both Houses of Parliament, the Freedom of the City of London, and a pension of £1,000 per annum from the Directors of the East India Company. In 1843, he was appointed Envoy at the Court of Oude, and in 1844 a Member of the Supreme Council of India. On his return to England he was nominated by the Crown one of the Directors of the East India Company. Sir George Pollock was one of the first who were decorated with the knighthood of the Star of India, and was created a Baronet on the 20th March, 1872, with the title of Sir George Pollock of the Khyber Pass.

On the death of Field Marshal Sir John Burgoyne, Sir George Pollock was appointed his successor as Constable of the Tower of London.

Sir George Pollock joined the Institution in 1849, was elected a Member of Council in 1850, a Vice-President in 1855, and a Vice-Patron in 1870.

The Council have elected Admiral of the Fleet, Sir Houston Stewart, G.C.B., a Vice-Patron of the Institution.

VICE-PRESIDENT.

12. The death of Colonel Sykes, M.P., F.R.S., deprives the Institution of one of its earliest Members. As Member of Council and as Vice-President he took an active part in the management of the affairs of the Institution, and was ever ready to further its interests.

The Council have elected General Sir William J. Codrington, G.C.B., a Vice-President of the Institution.

HONORARY MEMBERS.

13. During the past year the Council elected His late Majesty the Emperor Napoleon III, the Prince Imperial, and the Prince Hassan, second son of the Viceroy of Egypt, Honorary Members of the Institution.

Several Officers of foreign services were elected Honorary Members during their stay in this country.

CORRESPONDING MEMBERS OF COUNCIL.

14. It will be gratifying to the Members of the Institution to learn that the number of Corresponding Members of Council has increased from 334 to 349.

The Council thank the Corresponding Members for their past services, and express a hope that they will continue their efforts to make the advantages of the Institution more widely known.

CONCLUSION.

In concluding this, their Forty-Second Annual Report, the Council point with satisfaction to the marked increase in the number of the Members, to the sound state of the finances, and to the high estimation in which the Institution is held by the Services and by the country.

STATEMENT OF CHANGES AMONG THE MEMBERS SINCE 1ST JANUARY, 1872.

			Life.	Annual.	Total.
Number of Members, 31st December, 1871 ..			951	2,971	3,922
,, ,, joined during 1872 ..			73	263	336
			1,024	3,234	4,258
Changed from Annual to Life			+6	−6	
			1,030	3,228	4,258
	Life.	Annual.			
Deduct—Deaths during 1872 ..	21	83			
Withdrawals ..		38			
	21	121	21	121	142
Number of Members on 1st January, 1873 ..			1,009	3,107	4,116

TABULAR ANALYSIS OF THE STATE OF THE INSTITUTION,

To 31st of December, 1872.

Year. 1st Jan. to 31st Dec.	Annual Subs. received.	Entrance Fees.	Income (from all sources).*	Life Subs. received.	Amount of Stock.	Invested in the purchase of Books, &c.	No. of Vols. in Library.	No. of Members on the 31st Dec.	Number of Visitors
	£	£	£	£	£	£			
1831	654	..	654	1,194	..	..	..	1,437	..
1832	1,146	..	1,146	973	..	..	..	2,699	..
1833	1,405	..	1,450	692	..	..	..	3,341	..
1834	1,500	..	1,549	583	1,100	..	..	3,748	13,376
1835	1,480	..	1,574	366	2,430	40	..	4,155	8,537
1836	1,570	..	1,682	330	3,747	45	..	4,069	8,521
1837	1,549	..	1,747	222	4,747	180	..	4,164	10,907
1838	1,462	..	1,634	230	5,500	246	..	4,175	15,788
1839	1,399	..	1,565	168	5,500	292	..	4,186	16,248
1840	1,363	..	1,525	198	5,500	446	5,500	4,257	17,120
1841	1,450	..	1,643	186	6,000	243	5,850	4,243	19,421
1842	1,373	..	1,565	144	6,400	373	6,450	4,127	21,552
1843	1,299	..	1,494	140	6,700	237	7,000	4,078	27,056
1844	1,274	..	1,408	112	3,000	298	7,850	3,968	22,767
1845	1,313	..	1,466	228	1,500	127	8,100	3,988	21,627
1846	1,298	..	1,456	138	1,500	74	8,410	4,031	32,885
1847	1,314	74	1,502	132	1,700	37	..	4,017	38,699
1848	1,175	57	1,375	48	1,700	85	9,641	3,947	37,140
1849	1,176	72	1,375	84	1,150	58	..	3,970	33,333
1850	1,141	106	1,294	198	600	36	..	3,998	33,773
1851	1,136	131	1,292	66	666	34	10,150	3,188	52,173
1852	1,134	133	1,281	114	200	43	10,300	3,078	20,609
1853	1,243	319	1,684	264	528	41	10,420	3,251	25,952
1854	1,200	138	1,368	126	612	95	10,587	3,171	22,661
1855	1,159	107	1,289	120	653	55	10,780	3,131	14,778
1856	1,216	197	1,519	156	761	47	10,832	3,204	16,184
1857	1,258	176	1,937	78	1,038	40	10,960	3,168	12,755
1858	1,318	221	2,102	105	438	31	11,062	3,246	25,747
1859	1,526	195	2,277	512	946	70	11,320	3,344	28,739
1860	1,961	298	3,577	397	2,178	114	11,517	3,518	28,011
1861	2,122	305	2,899	266	2,846	99	11,812	3,689	23,296
1862	2,296	242	3,127	239	3,178	109	12,026	3,797	27,215
1863	2,379	218	3,100	405	3,583	143	12,296	3,847	18,150
1864	2,425	215	3,253	222	4,516	116	12,700	3,902	17,276
1865	2,435	154	3,467	235	4,804	137	13,000	3,895	18,253
1866	2,435	157	3,488	299	5,486	150	13,337	3,891	17,067
1867	2,431	141	3,467	208	5,732	140	13,800	3,823	17,211
1868	2,446	184	3,534	297	6,396	119	14,100	3,812	16,417
1869	2,368	165	3,485	238	6,653	232	14,660	3,792	15,947
1870	2,376	178	3,493	333	7,313	140	15,055	3,831	18,654
1871	2,455	237	3,677	538	7,748	202	15,501	3,922	19,420
1872	2,620	336	4,111	713	8,927	192	15,761	4,116	19,773

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* Including Annual Subscriptions, Entrance Fees, Donations, Legacies, and Interest on Funded Property also the Grant from Government, commencing in 1857.

IV. Admiral THE EARL OF LAUDERDALE, K.C.B.—

I beg to move the first Resolution, viz., "That the Report now read be adopted and printed for circulation amongst the Members." In doing so, I think I may congratulate the Members on the improved state of the Revenue on all points. I see at the end of the Report, a tabular statement of the different items, from which it appears that on every point the Revenue has increased. The "Annual Subscriptions" have considerably increased. The "Entrance Fees," and the "Income from all Sources" have also increased. The "Life Subscriptions" are greater than they have been since the year 1831; and I believe the large amount of Life Subscriptions received that year, was owing to Officers paying Life Compositions on the first establishment of the Institution. They amounted in that year to £1,194, and they have been as low as £48; this year they stand at £713, which is, as I say, greater than any year since 1831. The "Amount of Stock" has also increased considerably. The amount "Invested in the purchase of Books" has not increased, but the number of books has increased; which is better. The number of Members has largely increased, and the number of Visitors had increased also. I think, therefore, that we may fairly say that we are in an improving state. I am happy to see by the Report that the Government have withdrawn the "notice to quit" which we received so unexpectedly. I hope that the noble Marquis will use his interest for us, and that if they take these buildings or the site from us, they will give us another. I think it cannot now be disputed that this is a most important public institution belonging to the country. Government and the House of Commons think nothing of giving money to buy plants, pictures, statues, and they build houses to put them in; and this is all for the recreation of the people. But here is an Institution, which no man will deny has now become of the greatest importance to the country, not for pleasure, but in case we ever get into difficulties with foreign nations, to teach us how to defend ourselves, and also the best modes of carrying on war. These questions are here publicly discussed by professional men; and there is no other Institution in the country in which it can be done. I therefore hope that the Government will think seriously before they turn us out of our present buildings, as if we were some common Institution of little or no value to the country. I beg leave to move the Resolution.

The Resolution, having been seconded by Lieut.-General WILBRAHAM, C.B., was put from the Chair, and was carried unanimously.

V. The names of the eight Members retiring by rotation from the Council were read as follows:—

Colonel H. HUME, C.B.
Major C. B. BRACKENBURY, R.A.
Colonel F. C. A. STEPHENSON, C.B., Commanding Scots Fusilier Guards.
Captain W. D. MALTON.
Colonel A. H. LANE FOX.
Colonel H. A. OUVRY, C.B.
Major-General Sir ANDREW WAUGH, Kt., F.R.S.
Rear-Admiral J. W. TARLETON, C.B.

Lieut.-General M'Cleverty—

My Lords and Gentlemen, I have great pleasure in proposing the second Resolution, viz. :—

"That the thanks of this Meeting be given to the Members of the Council who retire by rotation; and that the following Members be elected to fill the vacancies, viz. :—

Col. H. Hume, C.B.
Col. Stephenson, C.B.
Maj.-Gen. Sir Andrew Waugh, Kt., F.R.S.
For Re-election
Rear-Adm. Sir Leopold J. Heath, K.C.B.
Col. Maitland, Lieut.-Gov. Chelsea Hospital.
Maj.-Gen. Schomberg, C.B., R.M.A.
Maj.-Gen. W. J. Smythe, R.A.
Col. Lord Elcho, M.P.

and that the following names be adopted from which to select in the event of vacancies occurring in the Council, viz. :—

Lieut.-Col. Lord William F. Seymour, Coldstream Guards.
Capt. G. Tryon, C.B., R.N."

I am sure, my Lords and Gentlemen, that you will all join with me in the Resolution which I have just now moved, viz., "That the thanks of this Meeting be given to the Members of the Council who retire by rotation." We are all indebted to them most sincerely for the trouble they have taken in the interests of this Institution—an Institution so valuable and so connected with the best interests of the Service. After what we have heard from Lord Lauderdale, I can have nothing more to say, excepting that the Report which has been read this morning, shews the interest that the Members of the Council have taken in forwarding the interests of the Institution.

Captain Wells, R.N., having seconded the Resolution,

Major Baylis, 36th Middlesex Rifle Volunteers, said—

Before the Resolution is put, I think I shall be in order in the few observations I have to make, with reference especially to that part of the Report which speaks of the tenure of the premises. I was present at the last Anniversary Meeting, when we were all of course naturally in a great state of anxiety as to whether we should be turned out of these premises or not. Since then we have received a letter withdrawing the notice to quit. But we must remember that we are liable at any time to receive a three months' notice. You are all well aware of the negotiation that has been going on for some time past between the Government and the Metropolitan Board of Works as to some land on the Embankment, and the result is, that an arrangement has been come to between them. But I do not think the Council can look to obtaining any site on the Embankment; a very large price has been paid for it, and we cannot look forward to obtaining a place there. I see the "Times" of to-day mentions a Society which has been promoted to erect a building to accommodate the London Learned and Scientific Societies, and which offers to provide a location for such Institutions as our own. I do not know to what extent the undertaking will be carried out, but I dare say you will permit me to draw your attention, and the attention of the Council, to it. The "Times" says:—"We understand a plan for providing a home and local habitation for such of these Societies as are not accommodated at Burlington House, has lately assumed a very definite form." It then goes on to say what they will do, and it probably might be worth the while of the Council to negotiate with that Society. I am sure no one can feel more than myself the value of this Institution, and the necessity that it should be put upon a permanent footing. I venture to make these remarks, seeing that the tenure under which we hold this Institution from the Government is of the most uncertain kind.

General Sir WM. CODRINGTON, G.C.B.—

With regard to the remark that has been made about the Metropolitan Board of Works and the agreement with the Government, I do not believe the Metropolitan Board of Works have any power of building at all on that ground ; consequently it is no question whether they can charge a price or not. I think we may very safely conclude that they would not give us land at a less price than it is worth. What we want rather, and that is what I hope the Council of this Institution will enforce upon the Government, is, that we should receive assistance with regard to our funds.

The Resolution was then put from the Chair and was carried unanimously.

Lieut.-General HODGE, C.B.—

I beg to propose the third Resolution, which is—

"That the thanks of this Meeting be given to the Auditors for their valuable services; and that the following Gentlemen be re-elected Auditors for the ensuing year:—

Captain J. E. A. DOLBY (for re-election).
T. G. RIDGWAY, Esq.
THOMAS SMITH, Esq."

As these Gentlemen, I understand, are kind enough to perform, for us, the office of auditing our accounts gratis, I am sure that the least we can do is to give them a hearty vote of thanks.

The Resolution having been seconded by Captain GORE JONES, R.N., was put from the Chair, and was carried unanimously.

The CHAIRMAN then announced that the business of the Meeting was concluded.

The Chair having been taken by Rear-Admiral Sir JOHN HAY, M.P., Vice-Chairman of the Council,

Sir WILLIAM CODRINGTON said—

Mr. Chairman, The interest that is taken in this Institution in high quarters, is shown at almost every Anniversary, besides many other Meetings, by the presence of Members of the Government, connected with the Army and Navy. We have been favored very much by that circumstance. We are to-day favored by the presence of a noble lord bearing a very historic name, who holds a high office with regard to the Army, and who has lent us his countenance, in approval, I hope, of the proceedings of this Institution, and of the system adopted here. There can be no doubt that there are many questions which are, to use the common term, "ventilated" and discussed, in a Society of this sort, that cannot well be ventilated and discussed by a Government, which would naturally be loath to give an opinion on subjects which we are free enough to give an opinion upon, in this Institution. Therefore it is that this Institution is one of great value; and that it is appreciated, is shown by the tribute which has been paid to it by the heads both of the Army and Navy. I therefore ask you to return your best thanks to the Marquis of Lansdowne for his kindness in coming here to-day, not only as an individual, but as, we hope, representing the goodwill of the Government towards this Institution.

Vice-Admiral Sir Frederick Nicolson, Bart., C.B.—

I have great pleasure in seconding the Resolution which has been so ably moved by Sir Wm. Codrington. I am sure it is needless to say anything further. As a Member of the Council, I may say this much, that we are always glad to find that those in high official situations connected with the two Services, are ready to lend us their countenance at our Annual Meetings.

The Resolution was then put from the Chair, and was carried with acclamation.

The Marquis of Lansdowne—

Sir John Hay, my Lords and Gentlemen, I hope that you will allow me to begin by saying that I am convinced that, if thanks are due from any one to-day, they are due from me and not to me. I esteem it a very great privilege to have been allowed by the Council of this Institution to take the Chair to-day. It has often occurred to me that one of the great advantages of public life—mine has been a very brief experience of such a life, but still it has convinced me of it none the less—is that it affords you opportunities of bringing yourself into contact with numbers of men, classes of men, associations of men, whom you would not otherwise have the privilege of meeting and knowing; and I can assure the Members present here to-day, that there is no association whose acquaintance I am more pleased to make, than that of the Royal United Service Institution. I say this not only as one of the general public who watch with an eye of approval and interest the energetic endeavours of this Institution, but I say it also as having the honour of being connected with one of the Public Departments, which will, I hope, continue always to preserve with this Institution, those amicable relations which I am convinced subsist between them. Added to this, I think I may congratulate myself upon having been allowed to occupy your Presidential Chair upon the occasion of certainly one of the most successful Meetings—I mean not so much in point of attendance, but successful in point of the condition of things which the Report discloses—that has ever been held. We have not only a very large and rapid increase in the number of Members of the Institution, but we have a very considerable financial increase as well; and I dwell with greater satisfaction upon this, because when I see the funded property of the Institution gradually increasing, it occurs to me that, should that unfortunate contingency which has been already referred to to-day, ever overtake us, the Institution will find itself with funds of its own whereby to second the effort which I believe will be made by any Government—whatever party it may belong to—to secure for the Royal United Service Institution a firm basis for the future. A reference to pledges which have been already given by persons holding high official positions in the present Government, is certainly reassuring on this subject; and I am convinced that those pledges were not only readily given, but will be honourably redeemed, when the day comes. On referring to your Report, I observe among the notices connected with this Institution, one notice upon which I wish to dwell for a moment, that is the mention of the names of those two gallant and distinguished officers who have passed away during the last year, I mean the names of Cochrane and Pollock. They need, I am sure, no recommendation from me; were it not that their predecessors are as numerous as they are distinguished, either of those names might be written up upon the walls of an Institution in which, like this, gallantry and intelligence, are held in high repute. I might mention the name of one other Member whom this Institution has lost, this time an Honorary Member, I mean his late Majesty the Emperor of the French. I am sure every Member of the Royal United Service Institution will join with me in reflecting that it is a source of congratulation to the Institution that among the many ties which bound the late Emperor of the French to this country, his Membership of this Institution was one. His tastes were eminently congenial to it, and I regret that it should have been ordained that he should continue so short a time to hold a place upon the muster-rolls of the Society.

Then, Gentlemen, having had the honour of filling the Chair to-day, I feel tempted to say a few words to you about your Institution itself, and I must confess that it is with some hesitation that I address myself to the task, because I run no inconsiderable risk of finding myself talking to you about a subject with regard to which you are very much better informed than I am. But there are one or two considerations that force themselves upon my mind, and those considerations I will, with your permission, very briefly state. We live in an age of great scientific progress. Inventions and discoveries succeed each other with remarkable rapidity, and for that reason increased scientific culture has become at once indispensable and more popular than it ever was before. We see that in every trade, in every profession, in every class of society, and I think this Institution may not unreasonably congratulate itself upon having for more than forty years taken the lead in that movement in the direction of scientific culture, which has added so much to the resources and strength of our country. We see that movement on every side of us. In the elementary schools, children are being taught some rudiments of science. It is the same in our great public schools; it is the same in the Universities; it is the same in the large centres of trade and commerce; and, last of all, it is the same,—and that in the highest possible degree,—in the Army and Navy. People are no longer content with that very one-sided literary education which sufficed in former days; and they begin to see that it is necessary to supplement what at one end of the ladder used to be called the three R's, and what at the other end of the ladder, used to be called elegant scholarship, with something more practical, more accurate, and more conducive to exact reasoning. This Institution has facilities for promoting scientific culture which perhaps no other Institution in the world has, for this reason, that we have here a neutral territory between science on the one hand and professional and practical life upon the other. The merits of the one frame of mind dovetail with the merits of the other; each corrects the faults of the other; and I think you get a more practical use of science in an Institution like this, than perhaps you do under any other conceivable circumstances.

I will not sit down without referring to the connection which has so long subsisted between the War Department and this Institution. I am happy to say that that connection is one on which both the War Department and the United Service Institution may reflect with pleasure. There has never been any approach to dependence between the two, but there has always been the utmost goodwill. We feel that we gain not only by the use made by Officers connected with the War Department of your valuable premises and of those facilities which you offer to them; but we feel that we gain in that wide diffusion of cultivated spirit which no Act of Parliament and no regulations can produce, but which the spontaneous efforts of this Institution have succeeded in very firmly establishing. My Lords and Gentlemen, I have only to thank you for having allowed me to occupy the Chair to-day, and to assure you it will be a great pleasure to me to look back upon my introduction to this Institution.

DONATION.

Captain W. D. Paine, 5th Surrey Rifle Volunteers, £2 12*s.*

NAMES OF MEMBERS

WHO JOINED THE INSTITUTION BETWEEN THE 9TH JULY AND 31ST DECEMBER, 1872.

LIFE.

Montagu, Philip, Lieut. 2nd Somerset Mil.
Hamilton, F. T. Tower, Midshipman R.N.
Longstaff, Lewellyn W., Capt. 1st East York Rifle Vols.
Sewell, H. Fane H., Capt. Madras Staff Corps.
Spratt, E. J. H., Lieut. 29th Regt.
Mackenzie, Colin, Capt. late 78th Highlanders.
Maltby, G. R., Sub-Lieut. R.N.
Imlach, R. W., Lieut.-Col. Georgetown Mil.
Daly, R. T. A., Lieut.-Col. Georgetown Mil.
Walker, Edward N., Capt. Georgetown Mil.
Hildyard, H. J. T., Lieut. 71st Highland Light Infantry.
Littleton, Hon. Algernon C., Lieut. R.N.
Barton, R. J., Lieut- 9th Lancers.
Selby, W. H. C., Lieut. R.N.
Fletcher, Henry M., Lieut. Roy. London Mil.
Prinsep, F. B., Captain 21st Hussars.
English, Thomas, Lieut. R.E.

ANNUAL.

Brady, Maziere K., Lieut. R.E.
Logan-Home, W. J. H., Lieut. R.E.
Brett, Henry, Colonel Unatt.
Holdsworth, John K., Major R.A.
Norcock, Chas. J., Lieut. R.N.
Dawson, Vesey J., Lieut. Coldm. Gds.
Willock, John H., Lieut. Roy. London Mil.
Hill, Thomas, Captain late 11th Regt.
Obbard, Harry S., Colonel Bengal Staff Corps.
Tanqueray, C. Waugh, Lieut. London Scottish Rifle Vols.
Gore, Augustus F., Lieut.-Col. Barbadoes Mil.
Owen, R. G., Lieut. 3rd Essex Art. Vols.
Barnard, John H., Lieut. 19th Regt.
Kerrich, W. D'O., Captain R.A.
Sankey, Wm., Colonel 62nd Regt.
Forsyth, T. H., Lieut. 62nd Regt.
Scourfield, John A. P., Lieut. 12th Roy. Lancers.
Holland, J. Y., Major R.M.L.I.
Draper, Edward T., Navy Agent.
Littledale, F. C. H., Lieut. 29th Regt.
Fraser, Chas. C., **V.C.**, CB., Col. 11th Hussars.
Heathcote, Henry F., Lieut. 103rd Regt.
Browne, W. B., Lieut. 46th Regt.
De la Poer, R. H., Lieut. 15th Regt.
Pidcock, Henry H. F., Lt. 103rd Regt.
Cornish, Charles O., Capt. 18th Royal Irish.
Fillingham, Charles A., Lt. 65th Regt.
Tubby, James H., Assist. Commissary-General.
Bullock, Geo. Mackworth, Lieut. 11th Regt.
Moore, Geo. Peter, Captain North Durham Mil.
Allison, James J., Major North Durham Mil.
Todd, T. Fentham, Lieut. 62nd Regt.
Robertson, D., Capt. 44th Madras Native Infantry.
Browne, Alex. A. P., Col. 109th Regt.
Warton, R. G., Lieut. 10th Regt.
Pead, Leonard W., Lieut. Suffolk Art. Mil.
Turner, Wm. Webb, Captain 3rd Sussex Art. Vols.
Maillard, Robt. T., Capt. 16th Lancers.
Carr, Ralph E., Major 36th Regt.
Whaley, Henry, Ensign 40th Middx. Rifle Vols.
Haslewood, Clement A., Lieut. 12th Middx. Rifle Vols.
Sedgwick, Leonard, Lieut. Royal Flint Mil.

ANNUAL MEMBERS—*continued.*

Banes, Geo. E., Maj. 3rd Essex Art. Vols.
More, George, Lt. 3rd Essex Art. Vols.
Wood, Patrick, Capt. 9th Essex Rifle Vols.
Cochrane, T. B. H., Midshipman R.N.
Comerford, James W., Capt. 22nd Middx. Rifle Vols.
Dorling, Francis, Lieut. 96th Regt.
Brayshaw, Benj. B., Lieut. 3rd Essex Art. Vols.
Maw, James, Capt. 3rd Essex Art. Vols.
Ansell, A. F., Major-General.
Scot, P. G., Colonel Bengal Staff Corps.
Scott, F. Sibbald, Sub-Lieut. R.N.
Hadow, Reginald T., Major Georgetown Mil.
Chawner, Harry, Lieut. Georgetown Mil.
Sandland, Robert, Lieut. Georgetown Mil.
Michalowski, F. H., Captain Georgetown Mil.
Hope, Charles, Lieut. 60th Rifles.
Byng, T. R., Capt. Madras Staff Corps.
Stone, W. Harry, Capt. Roy. So. Gloucester Mil.
Elliot, John, Colonel R.M.L.I.
Mountsteven, F. H., Capt. h.p. R.M.L.I.
Hawkes, R. T., Lieut. Beng. Staff Corps.
Gamlen, W. B., Ensign 23rd Middx. Rifle Vols.
Ibbetson, C. V., Lt. 4th Dragoon Gds.
Thornton, C. E., Major late S. O. of Pensioners.
Howitt, M. B., Capt. 3rd R. Surrey Mil.
Ward, J. W., Lieut. 8th King's Regt.
Fox, L. Loftus B., Capt. Roy. Longford Rifle Mil.
Hickey, R. J. F., Major late 101st Regt.
Berridge, T. Probyn, Lt.-Col. St. Kitts Mil.
Reid, William W., Capt. St. Kitts Horse Art. Mil.
Colthurst, James N., Major 6th Regt.
Graham, John, Capt. Pembroke Art. Mil.
Caldicott, Richard, Major 1st Warwick Rifle Vols.
Guest, Robert, Capt. 6th Lanc. Rif. Vols.
Lucas, Lewis Arthur, Capt. 6th Lanc. Rifle Vols.
Bury, J. T., Lieut. R.A.
Robertson, William, Major Madras Staff Corps.
Elias, Robert, Lieut. 59th Regt.
Hicks, John, Lieut. R.N.
Thelwall, E. D., Capt. R. M. Art.

ADDITIONS TO THE LIBRARY AND MUSEUM
DURING 1872.

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Where London is the place of Publication, the word London is omitted.
Where no size of Volume is mentioned, the Work is in 8vo.

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Plan d'Alger. 1870.
Carte de l'Afrique sous la domination des Romains (en deux feuilles). 1864. Notice sur la Carte, 1 vol. 4to. Paris, 1864.
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6 Diagrams, "H.M.S. Agincourt."
Captain Boyle, R.N.

District Cachar and Reconnaissance of the Looshai Country.
East Frontier, showing the Camps of Generals Bourchier and Brownlow.
Port Blair and the Jetty, Andaman Islands.
4 Maps, Turkestan.
Clements R. Markham, Esq., C.B.

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J. C. Young, Esq.

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The Danish Government.

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The Secretary of State for War.

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Capt. F. G. Burnaby, Royal Horse Guards.

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M. le Baron de Grancey. Military Attaché, French Embassy.

4 Sheets, Carta Generale del Regno Lombardo Veneto. 1859.
W. F. Higgins, Esq.

Charts published by the Hydrographic Office, Admiralty, from

January 1872 *to January* 1873.

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120. Schelde River, from the Sea to Antwerp.

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186. Mazzara to Palma, including the Island of Pantellaria.
187. Palma to Catania.
188. Catania to Cefalù, including the Strait of Messina (Preliminary Chart).

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527. Approaches to Demerara and Essequibo Rivers.

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757. Red Sea, Gulf of Suez (Preliminary Chart).

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840. Nicobar Islands, with Plans of Bays, &c.
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132. Channels between Misima Nada and Bingo Nada, Inland Sea.
2875. Seto Uchi or Inland Sea.

Section 14.

1016. Australia:—Bass Strait to Gabo Island.

New Zealand:—

719. Dusky and Breaksea Sounds, Middle Island.
720. Preservation and Chalky Inlets, Middle Island.

Section 15.

Pacific:—

767. Paumotu or Low Archipelago.
765. Union Group of Islands.
766. Ellis Islands, South-east Group of.
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Five Javelins and two Arrows from Port McKay, Queensland.

Rear-Admiral Sir John Hay, Bt., C.B., M.P.

A suit of Japanese Armour.

Maj.-Gen. Henry W. Whitfield.

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Mrs. Martin.

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Captain Whitla, 10th Regt.

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Captain Gillett.

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